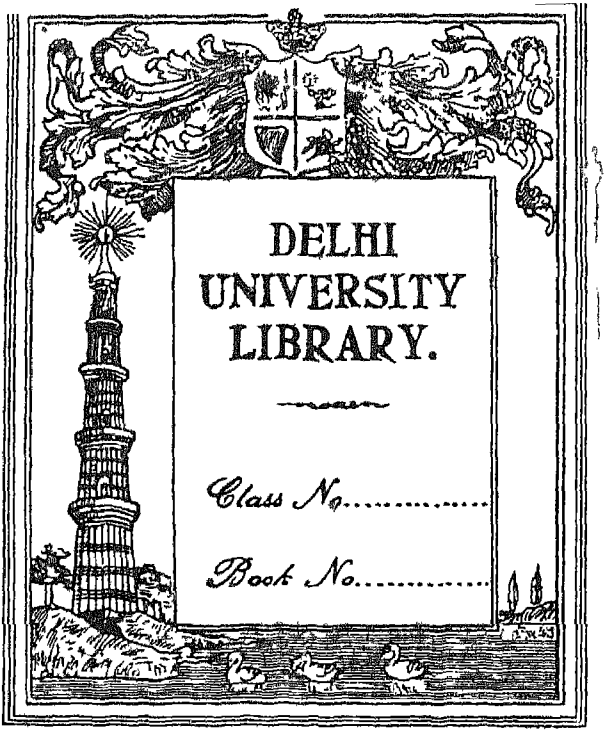

CLIMATE
AND
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BY

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PREFACE

In 1931, when Parliamentary Secretary to the Prime Minister, Ramsay MacDonald, I came into his room at the House of Commons one evening and found him most despondent and depressed. It was at the height of the economic crisis, and a National Government had just been formed under his lead. That crisis marked the end of many hopes that he and his colleagues had had of building 'a new Jerusalem in England's green and pleasant land'. 'Government,' he said, 'has become no more than an ambulance, and its success is measured by the speed with which it deals with disaster.'

Those words set me thinking deeply, and a few months later I decided to study the positive factors in building up a great civilization, or the causes of national greatness. I will not weary the reader with the long list of books that were read during a series of world tours during the next five years: they ranged from Gibbon's *Decline and Fall of the Roman Empire* to Hitler's *Mein Kampf*. Nowhere did I find the historical or philosophical solution, and it seemed indeed as if it was one of those problems which would defeat analysis until the end of time. But at this point I came across Buckle's *History of Civilization in England* and there read (vol. i, p. 6):

> Whoever is at all acquainted with what has been done during the last two centuries, must be aware that every generation demonstrates some events to be regular and predictable, which the preceding generation has declared to be irregular and unpredictable: so that the marked tendency of advancing civilization is to strengthen our belief in the universality of order, of method, and of law. This being the case, it follows that if any facts, or class of facts, have not yet been reduced to order, we, so far from pronouncing them to be irreducible, should rather be guided by our experience of the past, and should admit the probability that what we now call inexplicable will at some future time be explained. This expectation of discovering regularity in the midst of confusion is so familiar to scientific men, that among the most eminent of them it becomes an article of faith: and if the same expectation is not generally found among historians, it must be ascribed partly to their being of inferior ability to the investigators of nature, and partly to the greater complexity of those social phenomena with which their studies are concerned.

That quotation led me to embark upon a study of civilization from the scientific angle—and this book is the result.

Since civilization is produced by men—and therefore by individuals—the question arose as to what conditions render it possible

for a man to be at his best mentally and physically, for it seemed not illogical that where men do enjoy conditions that permit them to be at their best there are present the raw essentials of civilization. The resultant inquiries into climatic, health, and energy factors have led to conclusions set out here, and these are then translated in terms of national assessments. This book does not pretend to have discovered all the causes of great civilizations, but it does, I hope, shed light on one cause—that of climate and man's growing control of it.

Naturally in unravelling a single thread from the fabric of history it tends to attract more attention to itself than it should, but the reader will doubtless supply his own background of comparison and criticism.

I need hardly add that a work of this kind could not have been written without the skilled and always gladly given co-operation of archæologists, scientists, and government officials, and I should like to pay particular tribute to Dr. T. Bedford of the Industrial Health Research Board, Professor J. L. Myres, New College, Oxford, Dr. (now Lt.-Col.) Stanley Casson, New College, Oxford, Mr. Maurice Bennett, M.Sc., F.Inst.P., F.R.Met.S., Sir Paul Harvey, K.C.M.G., C.B., Mr. J. Macintyre, H.M. Office of Works, and Mr. E. L. Hawke, M.A., F.R.A.S., Secretary of the Royal Meteorological Society.

S. F. M.

August 1942.

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I

THE CAUSES OF ENERGY

THERE are two subjects which are of perennial interest to all thinking men and women: the first is their own particular fitness and energy, and the second is the rise and fall of nations or peoples. Yet few writers have considered the interrelation of the one with the other, and still fewer have attempted to assess a factor that has profoundly affected both, namely climate and our means of controlling it or of sheltering from it.

We all know that, as individuals, although we may be fit and well, there are days when we feel lethargic and dull, other days when we suffer from nervous tension and are irritable. We know too that certain peoples, such as the British, are regarded as phlegmatic, whilst others, such as the Italians or the Greeks, are regarded as much more excitable.

Mankind has always been ready with hypotheses to explain mysteries, and on the personal side we find that the moon, or the liver, one's diet, or one's bank balance, may be made accountable for much, whilst on the national side the greatest savants and statesmen of all epochs have suspected the existence of natural laws that govern nations even as others govern men.

It may perhaps be well to consider for a moment a few of the theories that have been held, often for centuries at a time, to explain the greatness of a people. Everyone knows that the Jews based their claim to racial superiority on the possession of 'The Book,' and in early days, indeed, the religion of a people was thought to account for much of its greatness. On the other hand there have been purely material reasons. The people of Akkad, thousands of years ago, acclaimed the idea that since Europe, Asia, and Africa spread out around them, their central position automatically destined them to be the leaders of the world. Akkad and its civilization have passed utterly away, followed by a succession of nations, each of which believed in turn that there was some feature in its climate, situation, form of government, or religion that made it the perfect society and the chosen of God. Thucydides, through the mouth of Pericles, attributed the eminence of Athens to its free democratic form of government. Greece fell before Rome, whose greatness Polybius ascribed to the blend of monarchical, aristocratic, and democratic elements in its constitution.

Centuries passed, in which Goth and Ostrogoth, Arab and Moor, advanced from power to power, claiming greatness from mighty gods or the Prophet of Islam. Centuries later the Venetians, heirs of the West Roman Empire, believed that because Venice lay in 45° of latitude—exactly half-way between the Equator and the North Pole—she was destined to perpetual world leadership; and only a few years ago an eminent British scientist, Sir John Herschel, held that Britain's greatness was due to her position at the centre of the world's land mass.

Another school of thought, vigorously expressed by Thomas Carlyle in his *Heroes and Hero Worship*, finds in leadership the key to history:

> The history of what man has accomplished in this world is at bottom the history of the great men who have walked here. They were the leaders of men, these great ones; the modellers, patterns, and in a wide sense creators, of whatsoever the general mass of men contrive to do or to attain.

On the other hand, many historians believe that the situation naturally and inevitably produces the necessary leaders. If there had not been Napoleon to terminate the French Revolution by a military despotism, there would have been some other; if there had not been Lenin to create the Soviet Republics, someone else would have risen to do it. No one man, or even a dozen great men, ever produced a great civilization. The greatest upward movements in history were not the work of individuals, but of many. A Julius Cæsar must have his legions; a Shakespeare must have his audience; a Britain acquisitive of empire must have its navy, its soldiers, its administrators, and its merchants. It is true that every civilization has produced its great figures, but they are its finest flowers and not its seeds. So little agreement is there on the part played by leadership in the development of the world.

Diet too has been advanced as a cause of national greatness, and the battle between various theories in this field has been long and inconclusive. Opponents of the dietetic theory agree that a well-balanced diet is essential to human health, but assert that there is scarcely a country in the world to-day where a balanced diet is not obtainable at reasonable cost, and that there is as much malnutrition through ignorance in some of the industrial areas of England as among many African and Asiatic races that rank much lower in the scale of civilization. Ill-balanced diets are, in fact, common throughout the world. But authorities on deficiency diseases, such as Sir Robert McCarrison of the Indian Medical

Service, are of the opinion that many native races of the East enjoy a perfectly balanced diet. Sir Robert, who worked for years as surgeon among the Hunzas of Northern India, writes:

> These people are unsurpassed in perfection of physique; they are long-lived, vigorous in youth and age, capable of great endurance and remarkably free from disease. . . . They live on a high plateau, difficult of access; and they depend very largely on food of their own growing: grains, pulses, fruits and green vegetables.

Sir Robert attended large numbers of these people, but in nine years he never saw a case of gastric or duodenal ulcer, of rheumatism or pneumonia, of appendicitis or cancer. Yet even their greatest admirers could not assert that the Hunzas had produced even the elements of a civilization.

To many others, like Dr. R. W. Cilento, 'The most outstanding fact in the world's history is disease and its distribution.' They aver that the rise or fall of civilizations coincides with the relative distribution of the two most vitiating and insidious diseases that afflict mankind—malaria and hookworm. Malaria, says Cilento,

> causes probably more invalidity than any other disease, while hookworm disease produces lethargy and dullness. . . . Excluding areas with less than two persons per square mile, progress and civilization are seen to be singularly related to the distribution of disease. The whole problem of civilization in any region consists in the degree to which endemic disease can be controlled, modified by the ease with which the human *organism can adapt itself to the situation.*[1]

This suggests the question, why single out malaria and hookworm? Are not tuberculosis and cancer equally energy-destroying and depressing? And if in some way malaria and hookworm are worse than any other diseases, why did Egypt, Greece, Rome, China, and Spain, all malarial countries, each produce a great civilization while the non-malarial centres of North-West Europe and Northern America, though populated, remained ingloriously supine?[2]

Every part of the world has its diseases, and every fatal disease has its prelude of disablement, depression, and decay. One is irresistibly reminded that Horace found that all men could be wise save when they had a cold in the head.

[1] R. W. Cilento, *The White Man in The Tropics*, pp. 67 et seq. See also below, Chapter IX.

[2] It is also noteworthy that a recent Carnegie Commission Report (mentioned in Chapter XI) states that the evidence refutes the frequent assertion that malaria exerts a profoundly deleterious effect. 'Malaria does not, on the average, cause severe deterioration of physique or nutrition. . . . This conclusion differs markedly from generally accepted views on the effects of malaria in the Transvaal.' See *The Poor White Problem in South Africa*, chap. iv, p. 116.

Race too, as we know, has been and is held to be the prime source of national greatness, but here again there is much contention. As long ago as 1300 B.C. the Egyptians attempted to portray the various races of mankind, and in the temple of Seti the Great, at Abydos, four varieties are represented—Egyptians, Negroes, Syrians, and a fair-haired, blue-eyed people from Libya—a striking contrast.[1]

Among the first of the modern scientists to propound a theory on race was the German anthropologist Blumenbach, who in 1811, as the result of the study of a large number of skulls from the Caucasus, and a comparison of these with Negroid and Mongolian types, first described the inhabitants of Europe as 'Caucasian,' without distinguishing, as has since been done, between Mediterranean (long-headed brunets), Alpine (stockier and round-headed), and Nordic stocks (blue-eyed blonds).

Max Müller, however, writing seventy years later, approached the question from the standpoint of language, and employed the term 'Aryas' for those who spoke languages classified as Indo-European or Indo-Germanic.

> Aryas are those who speak Aryan languages, whatever their colour, whatever their blood. . . . I mean neither blood nor bones, nor hair nor skull: I mean simply those who speak an Aryan language. The same applies to Hindus, Greeks, Romans, Germans, Celts, and Slavs.[2]

Max Müller was contemporary with those who insisted that this 'race' alone, the Aryans, had been the creator and sustainer of all that is good and great in civilization. The chief exponent of this theory of race supremacy, before the Nazi rulers of Germany gave it a new importance, was Count Joseph Arthur de Gobineau (1816–82), a French diplomat and author; he gave the name 'Nordic' to those descendants of the original Aryans who had settled in Northern Europe. However much one may challenge this or any other racial theory, it will at least not be denied that the 'Nordics,' whatever their origin, have been and still are a vigorous people; but the Nordics were almost barbarians when Mediterranean culture was at its height, and most certainly were barbarians when Egypt flourished. Nevertheless the Nordic legend persists. We are told that the glory of Greece was due solely to invasion of Nordic tribes, and its decline to the assimilated Levantine strain; that Rome was great and powerful so long, and only so long, as she kept her 'Nordic' blood pure; that the rise of Spain and

[1] Sir G. Elliot Smith, *Human History*.
[2] *Lectures on the Science of Language*.

of Portugal was to be attributed to the blood of Northern Visigoths, and their decline to its dilution by Indian and Negro blood. We are told too that the Renaissance was a purely Nordic phenomenon, although Gobineau himself denounced it as the triumph of anti-Teutonic forces. But in all truth we must admit that we do not know what was the racial composition of peoples even a thousand years ago. The Spartans have been classed, not as Nordics, but as Alpines by Dixon, while of the Etruscans, blithely claimed by many as Nordics, Hertz, the author of *Race and Civilization*, says, 'Only one fact seems established beyond all doubt, that they were not Indo-Germans or Nordics.'

To add to the confusion of thought on these racial issues, historians agree that the racial composition of the British Isles has changed very little since the twelfth or thirteenth century, when it was a small and relatively insignificant island kingdom, yet by 1600 this same people had become a world power. Neither has the racial composition of Japan changed during the last century—years which have seen her rise to heights undreamt of either by her forefathers or our own.

Recently, however, this philosophic theorizing as to the value of race has been supplemented by vigorous national action. In 1924, for instance, the United States, which hitherto was 'free to the world,' decided to close the gates to the immigration of certain less favoured races; in 1933 Nazi Germany, inspired by the same ideal, began its campaign of anti-Semitism; while at an even earlier date Australia decided to admit Anglo-Saxons only. The ideal behind all these policies is to build up a nation from the 'best' stocks, and in terms of modern nation-creating, as Germany, the United States, and Australia see it, the 'best' stocks are 'Nordic,' which in itself is almost indefinable.

Naturally the non-Nordic nations view this policy with mingled derision and alarm. As against the idea of Nordic superiority, the Latins proclaim that the Mediterranean gave birth to Western civilization, that Athens and Rome have been the teachers of the modern world, and that, if previously Egypt taught them, it is itself a Mediterranean country. Similar claims have been made, with equal force, to show the racial eminence of the Chinese, the Japanese, the Jews, and a score of other nations.

In the welter of modern ideas about race, it is almost impossible to avoid the appearance of bias in one direction or another. Racial theories have become bound up with political theories; many authorities declare there is no such thing in the world as a pure

race; anthropologists the world over are so divided in their views that there is no common acceptance of even the broadest racial divisions. Certain it is that all human races can interbreed, that languages of one race can be acquired by another, that migration and intermingling in all directions have gone on for countless ages, and that to-day national groups often include several distinct racial groups.

The opponents of the racial theory assert that a brief survey of history shows conclusively that no race has a monopoly of civilized leadership. Chinese, Semites, and Caucasians have all in turn climbed to the apex.[1] In war, in trade, in science, or in religious devotion, the sceptre of leadership appears to have passed from race to race almost without conscious effort on the part of the competitors. Even to-day the white world notes with trepidation the growing power and ingenuity of Japan, just as five hundred or a thousand years ago it dreaded the onrush of Turk or Moor.

To all these schools of thought there may be added the 'luck' school, which bases national advance on the discovery of some natural resource or some new method of agriculture, industry, or thought. For this school, the might of Great Britain, the U.S.A., and Germany is based upon their iron and coal resources. Conversely, the restricted civilizations of Mexico, Peru, and Yucatan were due to their lack of horses, cattle, and iron; had they possessed these, John Lothrop Motley suggests, they might have equalled the Greeks. Certainly great natural resources may bring great prosperity, but has not Nigeria greater natural resources than Denmark, or Brazil than the Netherlands?

Again, there are those who assert that intense pressure of numbers at the heart of a nation has been associated with every great colonizing or conquering outburst—though great outbursts have not always followed increasing numbers. As a general rule, human beings will congregate where the natural resources and climatic conditions are most favourable. Here they will flourish and multiply until at last the area cannot hold the teeming numbers. Then the adventurous will seek out fresh territories, but in order to occupy them must often develop more courage or more cunning than the occupants they wish to displace. Alternatively they must either improve their agricultural economy, or submit to a lower standard

[1] So far as we are now aware, Negroes and Red Indians have never led the rest of the world. Yet the history of the Zulus or of the Iroquois shows that in many characteristics, such as courage, they were, and perhaps still are, the equals of any race. Excepting the people of Liberia and Haiti alone, all the black races of the world acknowledge the political supremacy of the white man, and even these exceptions are perhaps due more to international jealousies than any great capacity or ability.

of life coupled with increased susceptibility to disease, which in turn produces a balance between man and his habitat.

No race or nation appears to have a *natural* fertility higher than that of another. The large Victorian families of our grandfathers are paralleled by the unchecked human productivity to-day of Guatemala, Costa Rica, Palestine, or Russia, all with an annual birth-rate of about 44 per 1000, and an annual excess of births over deaths of about 20 per 1000. At this rate the population of these four countries would double itself in fifty years. Obviously, if the land of these four countries has then to support double the population of to-day, either agricultural and industrial productivity must be increased, or new areas of settlement must be discovered: otherwise lack of nourishment will reduce resistance to disease, and the death-rate will increase. Nature in enabling man to breed so easily lays upon him the challenge to progress or die. Over-population may, indeed, cause a national decline through the reduced standard of living consequent upon unexpanding national resources.

Luxury, social habits, caste, etc., have also been advanced as causes of national decline, but the history of any great civilization shows that every one of these ills can be cured if the vital energy is there. The history of Rome is a succession of changing governments, of great victories after great defeats, of pestilence and famine alternating with plenty, until suddenly her power seemed to crumble; she ceased to produce men equal to the occasion, her energy dwindled, and the grandeur that was Rome ceased to be. If luxury was the reason, surely she could have rekindled her flame after the pillage by Genseric in 455? If malaria was the cause, why did not her decline occur at any time during the preceding thousand years? If the 'Baltic herring and Egyptian wheat' resulted in the decay of Roman agriculture and the annihilation of a sturdy peasant class, why was it that Rome could not, and did not, produce men capable of wise constructive measures?

Broadly speaking, national success has been variously attributed to religion, climate, race, pressure of population, diet, laws, language, the emergence of great men, trade routes, and so forth, and national decline to luxury, disease, social habits, caste, and the like.

It is not my purpose to investigate in detail these various opinions, but rather to ascertain if, in addition perhaps to these many causes, there is not a common factor which may also help to make a nation great and to give it cultural, economic, or political leadership of the world. This work seeks to determine whether or not climate and climatic control influence civilization.

II

CLIMATE AS A FACTOR

THE idea that climate is an important factor in the history of civilization is by no means a new one, for two thousand years ago Aristotle, Hippocrates, and Herodotus thought that the rise of Greece and the fall of the mighty empires of Asia Minor confirmed the excellence of the climate of Greece. Aristotle expressed the opinion that the colder countries of Europe had inhabitants full of spirit, but lacking in intelligence and skill; the Orient reared men gifted with intelligence and invention, but born to be slaves; but the Greek was high-spirited, intelligent, and a lover of freedom. Herodotus wrote of his own country, the western shore land of Asia Minor, and the Ionians who lived there:

> They set their cities in places more favoured by skies and seasons than any country known to us. For neither to the north of them, nor to the south, neither to the east nor to the west, does the land do for its people what Ionia does . . . it would seem that Hellas has the seasons tempered by far to the kindliest.

Not unnaturally such ideas were not expressed by Greek writers after Greece had been invaded by Rome, and still less were they mentioned when the whole of that part of Europe was overrun by the Turks.

But of late this theory of the importance of climate has been raised again by biologists, historians, and climatologists. The biologists assert that since for all other forms of life, whether plant or animal, there are certain conditions which produce the finest stocks, so for man there must be certain combinations of diet and climate which produce the most efficient and most energetic human beings. But since it is obvious that the leadership of civilization has moved from centre to centre in the last five or six thousand years the climatologists assert that there must have been climatic fluctuations of no mean degree and that in accordance with these fluctuations the focal points of civilization are continually, if imperceptibly, changing. Eminent American professors, such as Ellsworth Huntington and Lothrop Stoddart, stress this importance of climate, and the former asserts that Greece could not have attained her glory without a climate somewhat similar to that of Chicago to-day.

No exponent of this theory of climatic change has attained greater popularity, or suffered more criticism, than Ellsworth

Huntington, who states plainly that a great part of his work stands or falls by a theory of climatic pulsation in historic times. The following extract from his *Civilization and Climate* will give an idea of the argument:

> Suppose that from 500 to 400 B C. Athens had (1) a mean annual temperature of 62° instead of 63·1°; (2) a relative humidity at all seasons 10 per cent. higher than now; (3) an annual rainfall of 22 inches instead of 15 inches; (4) number of storms twice as great as now. The result of the change is astonishing . . . Athens rises to a level practically the same as that of New York or Chicago, and enterprise, physical vigour, and mental activity result.

But even with these changes, the climate of Athens could scarcely be compared with that of Chicago of to-day, for where Athens has an annual mean temperature of 63·2° F., Chicago has an annual mean of 50° F., and is thus on the average 13° or 14° cooler than Athens.[1] Had the winter climate of Greece been as cold as that of Chicago, the olive and the vine, for which there is so much historical evidence, certainly would not have flourished. Athens is in fact over twenty degrees warmer than Chicago in January, 49° compared with 26°. Innumerable historical documents tend to show that the temperature of the East Mediterranean has remained practically unchanged since the time of the Pharaohs.

But even if there were changes, surely these would have spread to neighbouring areas, such as Turkey, which, instead of remaining obstinately somnolent as Crete did for two thousand years, surged westwards and shook Europe to the gates of Vienna.

Great climatic changes have undoubtedly taken place in the course of the world's history, but these have been so slow that to hold them responsible for great national upsurges in modern times is to lay too much to Nature's account. The base of these theories is that the radiation from the sun varies from epoch to epoch, and that in accordance with these changes the polar ice caps advance or recede.

Dr. C. E. P. Brooks, Dr. Ernest Antevs, and others have pointed out, and appear to have proved conclusively, that the polar ice caps are still retreating at the rate of about 500 feet per year, with oscillations; that the oceans are steadily rising at the rate of a fraction of an inch per century owing to the melting of the ice at the poles; and that the temperature of the world is gradually rising, owing to the return to 'genial' conditions of the world as a whole and to the gradual decline in the refrigerating effects of the great polar ice caps.

[1] See E. G. Mariolopoulos, *Étude sur le climat de la Grèce* (Paris, 1925), for a refutation of Huntington's theory.

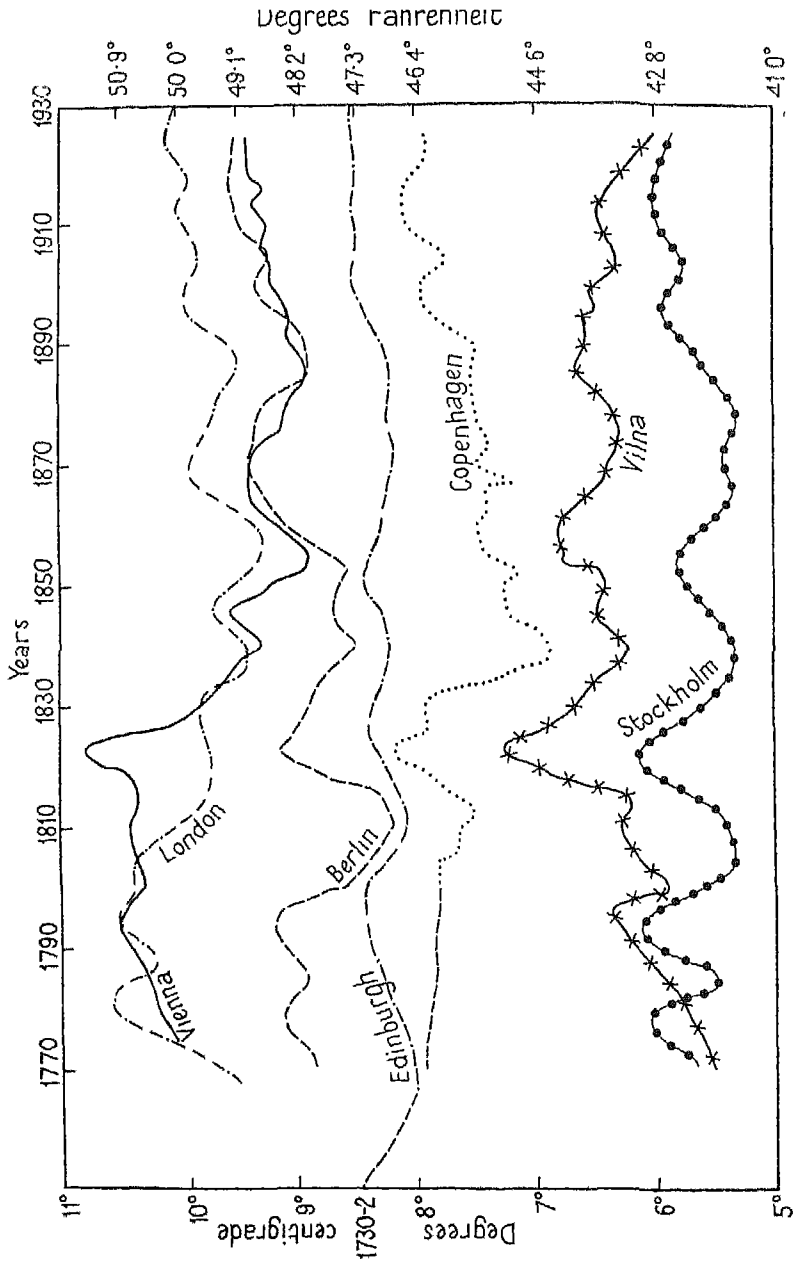

CHART SHOWING THE FLUCTUATIONS IN TEMPERATURES OF EUROPEAN CITIES FOR WHICH RECORDS GO BACK OVER 150 YEARS

The lines have been smoothed out over twenty-year periods; thus the temperatures shown for the year 1850 is the average of temperatures for 1840–1850.

One of the outstanding illustrations of this theory is that the ice-front in Glacier Bay, Alaska, has retreated about sixty miles in about one hundred and forty years, i.e. from the time of Captain George Vancouver's first survey in 1794 to the latest report of the District Engineer of Victoria, B.C. Possibly there has been quite a warming up of the climate in this area, but if we take the meteorological records over the same period (1770–1936) [1] for those cities in Europe for which such records are available, we find little evidence of a general warming up. In Vienna, temperatures have declined by about 1° F., whilst in Vilna and Berlin, on the contrary, they have risen by about 1° F. Now it is obviously impossible to conclude that Vienna has been getting progressively cooler over the centuries, if Berlin and Vilna have been getting warmer. The only conclusion that can be drawn is that from year to year, and from decade to decade, climate fluctuates in every centre, and that whilst areas near the poles may be warming up, owing to recession of the polar ice caps, there is little evidence of any comparable rise of temperature nearer the tropics.

Evidence from other sources confirms this view. Archæologists and phenologists are united in thinking that there is little or no proof of any dramatic change in *temperature* during the past two thousand years in Greece or Italy, though there is very definite proof that the lands of Babylonia, Persia, Egypt, and even India, at the height of their long period of glory, were *moister* than to-day. For the moment we are content to record the statement of Sir Ernest Wallis Budge and other Egyptologists of the British Museum that

> although certainly less dry than now, the climate [of Egypt] cannot have differed very greatly from that of the present day. . . . In earlier days, no doubt, this was not so: then the rainfall was constant, and the desert wadis with their water-worn rocks and pebbles were formed, which, though now they have been dry for millennia, still preserve the appearance of dry watercourses. . . . The Nile valley was in palæolithic days simply a swamp.[2]

Similarly in India, Sir John Marshall, Dr. J. H. Hutton, and others point out that

> Everywhere in southern Baluchistan there are remains of enormous dams and *bands*, proving that at one time the land was elaborately irrigated and pointing perhaps to the period at which its natural waters began to fail on account of climatic changes involving the undertaking of conservancy on a larger scale, and we are probably justified in picturing

[1] Given in *World Weather Records*, published by the Smithsonian Institution of Washington. See also Prof. D. Brunt, *Geographical Journal*, March 1937.

[2] *Guide to the Egyptian Collections* (The British Museum, 1930), p. 274.

Baluchistan, a land of hills and valleys indeed, but now barren and wind-swept, as five thousand years ago (period of the Mohenjodaro civilization) a good land of fountains and depths, drinking water of the rain of Heaven.[1]

Again, all authorities agree that thousands of years ago the Persian Gulf extended a full 250 miles farther north, even if only a tidal swamp for its northernmost reach, that the oasis of Kharga in the Egyptian desert was an extensive lake, and that the Caspian Sea was much larger than to-day.[2] Thus the whole of this area, from Persia to Egypt and from Arabia to the Caucasus, while it may not have been much cooler thousands of years ago than to-day, certainly had a heavier rainfall, and also had a less extreme range of temperature owing to the greater water expanse of the period.

This recession of the waters is a fact of prime importance in considering the history of Babylon and indeed that of the whole region from Egypt to Persia; it would have had a powerful modifying effect on the climate, and, furthermore, ancient cities such as Sumer, Larsa, Susa, Al Ubaid, Ur, and Endu, now from 150 to 200 miles inland, would then have been, if not on the sea-coast, at least within easy reach of the sea.

This region, therefore, must have presented at that period of the world's history a well-watered, fertile plain with a less extreme climate than to-day; and all the investigations that have been carried out by archæologists seem to bear out this conclusion. Sir Leonard Woolley, for instance, records that the temperature at Ur nowadays rises from below freezing-point in winter to a summer maximum of 137° F. in the shade, and that dust storms are so dense that the sun sometimes cannot be seen for six weeks on end.

Had this always been the case, Ur could never have been a great city: that it was great is proof that the conditions of the climate were not then the same. To-day the difference of temperature between Ur and Nasiriyah, only eleven miles away, may be of 10° or more, and that is because round Nasiriyah there is a cultivated belt, and the Euphrates flows beside it (as it formerly flowed by Ur) and there are not great expanses of sand to reflect heat. When all was fertile, the soil being irrigated by innumerable channels, there were no such extremes of heat and cold as there now are.

Woolley goes on to say that in 2000 B.C. the population of Ur would be about 500,000, for it consisted of four square miles of

[1] *Census of India*, 1931, vol. i, p. 454.

[2] Herodotus (485 B.C.) describes the Caspian as being then six times longer than its breadth. From this, Huntington infers that the Caspian was then 185 feet higher than its present level, and united with the Sea of Aral. See Brooks, *Climate through the Ages*, p. 361.

closely packed houses.[1] To-day the city of Basra has a population of only 85,000.

Much attention has also been paid, in respect of climatic influences, to the ancient Indian civilization at Mohenjodaro, and Mrs. D. Mackay says:

> From the evidence of the seals found in the ancient city of Mohenjodaro it seems certain that the climate of the Indus Valley was far moister five thousand years ago than it is to-day. On their seals the craftsmen of Mohenjodaro portrayed with the faithfulness of familiarity those denizens of moist, lush jungle—the elephant, tiger, and rhinoceros—which are no longer known in Sind. The lion, a lover of dry open country, has not yet been found on seal, amulet, or painted pottery. He was evidently almost unknown, though to-day he roams the hills of Kathiawar, not far south of Sind. Moreover, it must have taken immense quantities of wood to burn the bricks required in the construction of a city so large as that which excavation has revealed at Mohenjodaro—a fact which argues a more thickly wooded condition of the Sind country than that which exists at present.[2]

Other evidence in this direction has been most carefully considered and sifted by Dr. C. E. P. Brooks in his *Climate through the Ages*, who, in addition to supporting the theory of climatic changes in Northern Africa and Western Asia, gives a 'generalized temperature curve' for Europe showing that from 250 B.C. to A.D. 250 the climate was 'cool'; from A.D. 250 to about A.D. 900 'comparatively warm,' and from A.D. 900 to the present day, fluctuating between these two extremes, but generally below the average.[3]

Thus during the last 40,000 years it may be agreed that there has been a warming up of the climate of the north temperate regions (and, by inference, of the south temperate regions), but that this warming up, if it were steady, would not amount to more than 1° F. per 1000 years.

Now a steady rise in the temperature of these regions of not more than 1° F. per 1000 years would not have resulted in serious changes in the temperature of any of those areas in which civilization has flourished.

Rome and Athens were at their zenith about two thousand years ago, Egypt and Babylon about four thousand years ago; therefore, if we suspect a maximum increase of 1° per 1000 years, we cannot

[1] C. L. Woolley, *Ur Excavations*, pp. 2 et seq.

[2] *Geographical Magazine*, August 1935.

[3] Professor J. B. S. Haldane, in his *Keeping Cool*, pp. 2 and 196, says 'From 1800 B.C. to 450 A.D. the weather (in N.W. Europe) was much wetter than at present, and between 450 and 1000 A.D. much warmer and drier than it is now.'

attribute to them in those times temperatures approaching those of Chicago, New York, or London at the present day.

Thus, whilst there may be reason to think that the climate of Egypt, Babylon, India, etc., may have been anything up to 5° cooler three or four thousand years ago, there is little reason to suspect a drop of about 15°, which is required by the Huntington hypothesis. The whole weight of scientific investigation, whether astronomical, archæological, or phenological, is against such a supposition. There is, however, much ground for supposing that most of these areas were moister then than to-day, and whilst this might explain their greater prosperity in those times, it would not account for the transfer of world-leadership from those regions to north-west Europe and northern America during the last five hundred years.

We must, indeed, look deeper for the causes of the growth of civilization, avoiding bias either in favour of a particular nation, race, or religion. After a full consideration, I am convinced that one of the basic reasons for the rise of a nation in modern times is its control over climatic conditions: that the nation which has led the world, leads the world, and will lead the world, is that nation which lives in a climate, indoor and outdoor, nearest to the ideal, provided always that its numbers are large enough to resist invasion by its rivals. Civilization to a great degree depends upon climate control in a good natural climate.

III

HUMAN REACTIONS

Of all the factors that may assist or retard the development of a nation the most permanent, if it is a factor, is climate. Great men come and go, and their wisdom is often undone by successors less noble; laws are rescinded; races intermarry with other races; economic resources vary in importance with changing needs. But climate, fickle and changeable as it is, is still the most stable, the most consistent, and in many ways one of the least controllable of all external effects that influence men.

Every second of the day the environmental factors of temperature, humidity, air movement, and radiation are having their effect upon our bodies and our energies, and there is not the slightest doubt that the ideal combination of these factors goes a long way towards enabling men to be healthier and more energetic.

We have, therefore, first to consider whether there is an ideal climate in which man will thrive better than in others. We all know that men die from sunstroke, or from being frozen, and one obvious condition of the ideal climate is that it must neither kill nor incapacitate a man. Since freezing-point is 32° F. and sunstroke-point near 100° F. it might be assumed that the ideal is about midway between these two extremes—i.e. about 66° F.—but the problem is not quite so simple as this.

One of the conditions of health and energy is the maintenance of a constant body temperature, and in man the average mouth temperature should be about 98·4° F., and the temperature of the deep tissues about 99° F. In health these temperatures vary but slightly. The body temperature is controlled by physiological mechanisms which regulate both the heat production within the body and the rate of loss of heat from its surface.

Human beings lose heat (1) by radiation to surrounding surfaces, (2) by conduction to the surrounding air, and (3) by evaporation through insensible perspiration and by sweating. Insensible perspiration occurs even in a cold environment and increases in warm surroundings. Sweating is due to the sweat glands of the skin, and may be regarded as an emergency mechanism which operates when the loss of heat by other methods is insufficient.

The rate or mode of loss of heat from the body is, of course, greatly influenced by radiation, by the temperature, velocity, and

humidity of the air, and by the activity of the individual. These factors are naturally rarely the same for any length of time, and their ceaseless variation relieves us from monotony and drowsiness and stimulates tone and metabolism.

The calm serenity of the Elysian fields may be ideal for the gods, but for mere mortals, alternations of excitement and tranquillity, both mental and physical, in their due proportions, bring us near to the classic ideal of *mens sana in corpore sano*. But the changes must not be too great. Man may be the highest product of the animal kingdom, the most intelligent and the most adaptable, a superb triumph of evolution, but his control of body temperature is feeble compared with that of many animals. The bat can survive a change in its own body temperature of 60° F. or more, while most animals possess some form of temperature control, from the adjustable feathers of birds to the honeycomb of the elephant's ear serving as an air-cooled radiator for the blood. Even dogs can suffer a change of three or four degrees in their body temperature without inconvenience, but man must keep his body's temperature near 98·4° F. or die.

How are we to assess our climatic environment and its effects? It must be admitted at once that there is no instrument universally accepted which will give us an accurate idea of the comfort factors in the atmosphere. The Kata thermometer, the eupatheoscope, and other instruments, which are decidedly better than the dry bulb thermometer in this respect, are limited in their application, and for the purpose of this work we must have some measure of climatic conditions that meets with general acceptance. The thermometer, whilst an inferior instrument for measuring environmental conditions that are healthy and comfortable, since it merely indicates the temperature of the air in its immediate vicinity and ignores numerous other factors, has won such acceptance. Moreover, there are available for every large city of the world day-by-day thermometer readings which in some cases go back for two centuries, thus affording an historical as well as a current method of ascertaining climates.

But environmental warmth, which the thermometer indicates, is only one of the atmospheric factors affecting human comfort and energy. Humidity, air movement, and radiation all play their part, while still unknown factors, such as the electrical content of the air, may have more to do with human energy than we yet imagine.

The combination of heat and humidity, in particular, is one

which the human body cannot gladly endure, and humanity has devised little protection against such conditions. Since moist heat at 80° F. may cause sunstroke, while a dry heat of 100° F. can be safely endured, it is important that we should know the degree of moisture in the air. Humidity can be tested by a comparison of the dry and wet bulb thermometer, or by hygrometers, and in this respect figures for relative humidity (i.e. the percentage of saturation) are obtainable for every large city of the world.[1]

Like temperature, the relative humidity of the atmosphere changes every hour, but in spite of fluctuations it is almost as steady as temperature. We therefore accept it as the second most important factor in the climate, with air movement as the third.

In considering outdoor climates we must further add the important factor of radiation, i.e. the direct effect of the sun.

I have attached much less importance to air movement and radiation than to temperature and relative humidity for this reason, that although we cannot and do not evade unpleasant air movements or excessive radiation completely, we can and do evade them more easily than high temperatures or high humidity. In bad weather we can avoid wind by getting into buildings or vehicles. A gale becomes still air indoors, but humidity persists indoors and outdoors except during the winter months, when doors and windows have been closed and heating apparatus brought into play. Moreover, the effects of varying climates will be difficult enough to estimate on temperature and relative humidity readings alone, and air movement and radiation would complicate the issue so much that for clarity's sake they must be omitted.[2]

The meteorological offices of this and of other countries have

[1] The wet bulb thermometer is perhaps a better indicator of atmospheric conditions from the point of view of energy and comfort, and some authorities have placed full reliance on this instrument. It may be asked why we should not take, as do Griffiths Taylor, Haldane, and others, the wet bulb thermometer alone, or alternatively, the water-vapour content? The wet bulb thermometer alone still exaggerates the effect of temperature and makes no allowance for oppression induced by high humidity; while the water-vapour content figures are difficult to ascertain for comparison. Both the wet and dry bulb thermometers indicate the effect of temperature on themselves; they do not show the cooling and evaporating power of the environment on the skin and the respiratory membranes. They are static instruments, while the body is dynamic, producing heat which must be lost at an equal rate to keep the body temperature normal. See *The Kata Thermometer and Efficiency* by Sir Leonard Hill, which should be read in connection with this chapter.

[2] Unless otherwise stated, it is assumed that all climatic factors are associated with unspecified air movements varying as do the air movements of the British Isles, and the climatic factors are not corrected for air movement except in such cases as the calms of India or the gales of Patagonia, where air movement is an important vital fact in our inquiry.

for approximately a century, in many cases, recorded weather conditions in their respective areas, but nearly always in terms of the dry bulb thermometer, relative humidity, hours of sunshine, and air movement. So, for want of any better standards that can be applied to the whole world, we are compelled to rely on these readings, whilst endeavouring to interpret them in terms of cooling power, radiant energy, and drying power.

As I have said, the temperature recorded by the thermometer does not always agree with the sensations of heat felt by the human body, since the thermometer disregards the cooling effect of wind or the oppressive effect of high humidity.

The ideal warmth is that which permits the waste heat of the body to be dissipated as soon as developed, neither too fast nor too slowly, in order that the body's temperature may be maintained at the required 98·4° F. Dry air mitigates heat by accelerating evaporation from the skin, but very dry air produces in the human being excessive nervous excitability and sleeplessness.[1] Moist climates have the opposite effect of producing nervous depression and lethargy. Now, whilst the complicated human mechanism of heat elimination will adjust itself to a considerable range of external temperature or moisture, it adjusts itself at the expense of energy and efficiency.

Is there then an 'optimum' climate for man irrespective of his race, origin, or traditional environment?

It can be said at once that there is no specific optimum, but that there is an optimum range, and the optimum range covers temperatures, humidities, and so forth, suitable for man in all that great variety of states from profound slumber to extreme physical exertion. It is, perhaps, easier to obtain the slumber optimum than the optimum for any other state, since environmental sleeping factors all over the world vary much less than environmental action factors. No matter in what part of the world a man may be, with the possible exception of the equatorial heat belt, he demands, as his ideal sleeping conditions, darkness, still—or only lightly moving—air, and a temperature somewhere between 75° F. and 80° F.[2]

[1] Ruttledge on his Everest expedition noted that the altitude and dryness made it impossible to sleep, and caused agony in teeth and intense irritability. The party degenerated rapidly, becoming less energetic and losing appetite and weight. (See *Everest, 1933*, pp. 262–263.)

[2] See J. Macintyre in the *Journal of the Institution of Heating and Ventilating Engineers*, February 1937. This temperature is the temperature in the immediate vicinity of the skin, and in cold climates therefore would be the temperature under the bedclothes and not in the room.

If the environmental temperature is lower than this, he will seek, by means of heating apparatus, bedclothes, or even by huddling himself up, to raise the temperature, within a few millimetres of the skin, to this level, and if the head is exposed to a colder atmosphere a higher environmental body temperature will be required in compensation. Thus it may be said that the ideal atmospheric condition for man, when at absolute rest, is a temperature approximately 75° F. to 80° F., with lightly moving air.

But it is when the man that we have in mind wakes up that the number of variables affecting his environmental atmosphere increases. First, there is the increased pace at which the body itself works, the faster pulse, the effects of meals, with the consequent improvement of bodily heat production; then the effect of movement in another form, that is of increasing the pace of the air-flow round the body, the effect of radiation whether it be from a fire or from sunshine, the effect of varying humidities, from the high moisture content of a bathroom to the drier atmosphere of an ordinary sitting-room or office. All these changes can occur indoors, but the moment the man goes out of doors all these factors are complicated by still greater air movement, which may vary from a slight breeze to a violent gust; by radiation, which may differ greatly as a lightly clothed body passes from shade to sunshine; and by other factors such as the effect of rain on the face or limbs, or the electric content of the air, about which we know even less than about temperature and humidity.

It is interesting to note at what temperature and humidity feelings of oppressiveness, laziness, or lethargy first become apparent. In this respect some very careful work was done years ago by M. Lancaster of the Belgian Meteorological Service, who as the result of many experiments came to the conclusion that there was an oppression curve beginning at 70° or lower, when the relative humidity is 80 per cent. or over, and extending to 82° with the low humidity of 44 per cent. My own experience, which includes many months of residence in India, Africa, and the Dutch East Indies, shows that whenever the thermometer rises over 85° and humidity exceeds 85 per cent., the feeling of oppression is accompanied by distinct laziness, but the oppressive feeling is very much modified if there is a breeze of 20 m.p.h. or more. Thus a ride in an open car at 85° and 80 per cent. relative humidity (average conditions in the Dutch East Indies) is quite pleasant, but the moment the motion through the air ceases the feeling of oppression becomes quite perceptible. At 90° or over, wind seems to make

no difference, and I have never found 90° pleasant under any conditions, whether humidity be low or not.

On the other hand, a feeling of chilliness arises when any part of the body is exposed to temperatures of less than 50° F., unless the body is in active movement, and with lower temperatures chilliness gives place to shivering and great discomfort.

Thus it may be said as a broad rule that all temperatures over, say, 85° F. and all below 45° are distinctly unpleasant to an exposed body, and that one's energy and health suffer in some way if these conditions have to be endured for any length of time.

I turn with relief from rough approximations of this kind to consider the many scientific investigations and tests that have been made, notably in England and the United States, to ascertain what are the 'best' climatic conditions. Not unnaturally these investigations have mainly been concerned with factory or office conditions.

It must be remembered that there are four distinct cooling rates for the human body:

(1) The cooling rate associated with a dry naked body, as, for example, when sun-bathing.

(2) The cooling rate of a wet naked body, as, for example, after a swim or a bath.

(3) The cooling rate of a body dryly clothed, which rate in turn varies with the weight, texture, and cut of the clothing. Close-fitting woollen underwear, for example, will conserve heat in a much more effective manner than the toga of antiquity with its loose, rippling folds hanging from the shoulders, or the Greek chiton.

(4) The cooling rate of a body clothed in wet clothes.

Of these all but the third may be regarded as abnormal conditions in civilized countries—that is to say, that whilst one may frequently sun-bathe, or swim, or get wet through, it is much more usual to be dryly clad, and therefore it is this condition we shall have in mind in the succeeding pages.

All investigators are agreed that extremes of heat or cold, of humidity or dryness, of air movement or stillness, militate against the full exercise by the human animal of his powers and abilities, but there is still some divergence of opinion as to the precise happy medium in respect of all these conditions.

We must therefore consider briefly the conclusions of the two main investigations, the one British and the other American. On the British side there have been a series of inquiries under the ægis of the Department of Scientific and Industrial Research headed by Dr. H. M. Vernon and Dr. T. Bedford. The former, in his

Principles of Heating and Ventilation, states that the ideal temperature with a slight air movement (i.e. 50 feet per minute or less) is 66·1° F. in summer and 62·1° F. in winter, and this estimate is supplemented by Dr. T. Bedford, who, in his *The Warmth Factor*, gives 64·7° F. as the ideal indoor winter temperature. On the other hand, the principal American investigations conducted by the Research Laboratory of the U.S. Bureau of Mines at Pittsburgh (F. C. Houghton, C. P. Yaglou, and others) led to the conclusion that, in still air, the ideal indoor temperature is 75·7° F. in summer and 70° F. in winter.[1] Other investigators, including German, give ideals between the British and American optima quoted above.

All observers agree:

(*a*) that lower temperatures are required with increasing humidity —broadly speaking, the ideal temperature is reduced by one degree for every increase of 6 per cent. in the relative humidity;

(*b*) that in still air temperatures over 76° are uncomfortable save only at low humidities;

(*c*) that with a relative humidity of over 80 per cent., temperatures over 70° in still air are uncomfortable;

(*d*) that temperatures below 60° are uncomfortable for sedentary or light work, except for children, for whom temperatures of 58° to 60° have been recommended by some investigators;

(*e*) that no single index of comfort exists, i.e. that acclimatization over a short or long period renders temperatures slightly above or below the ideal agreeable, and that age or youth plays its part in individual reactions.

But whilst there is therefore much agreement there is an apparent divergence of several degrees between the American and the English ideals of temperature. The question is, would Dr. Vernon's Englishman, working happily at 62·1° F., feel comfortable and energetic in Pittsburgh at 70·5° F.? The problem is one that has exercised the minds of both sets of investigators for several years, and great efforts have been made to explain this difference. The conclusion is that the American worker is most efficient in a temperature a few degrees higher than his English cousin because:

(1) The American summer being drier and hotter than the English summer, and American houses, factories, etc., through different heating methods, being warmer in winter than the English, the American worker is accustomed to higher temperatures and greater dryness.

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[1] These figures may be compared with Bedford's 'comfort zone', which ranges from 55·8° to 73·7°, and Yaglou and Drinker's 'comfort zone', which ranges from 66° to 75° in the American summer and from 63° to 71° in the American winter. See Bedford, *The Warmth Factor*, p. 34, and the *Transactions of the Institution of Heating and Ventilating Engineers*, vol. 35 (1929). The German ideal, given in the symposium *Klima, Wetter, Mensch* (Leipzig, Quelle & Meyer, 1938), is 69·5° F. with 50% relative humidity.

(2) Americans wear fewer or lighter clothes than Englishmen. The 'weights' of underclothing popular in the two countries reveal an interesting difference, while the Englishman's reluctance to leave off a waistcoat, or, in the case of office workers, to work in shirt-sleeves in hot weather also has a bearing on the matter.

If due allowance is made for these factors, it will be seen that the difference between the American and English ideals approaches vanishing-point, and is at most of only one or two degrees.

Since the difference is so small when compared with weather variations, I propose to accept the whole range of temperatures from 60° F. to 76° F. as constituting an ideal zone, with relative humidities varying from 40 per cent. to 70 per cent. In other words, any local 'ideal,' whether it be that of Pittsburgh or of London, is accepted as part of a world ideal.

This wide range of temperatures permits a still greater difference of clothing. If the American, in his light cotton underwear and no coat, prefers an average temperature of about 73°, it follows that the Indian in his loin-cloth, or the industrial worker stripped to the waist, may prefer to go up to 76°, but the cooling effect of moving air on the naked body should not be overlooked here; while the Scandinavians or the Scots, with still heavier clothing than the English, may prefer a temperature lower than the English average of 65°.

We thus come back to the first conclusion that, provided men are suitably clothed, the temperature range in which they will produce their greatest and most efficient output is between 60° and 76°, according to the relative humidity, amount of clothing worn, and the worker's own movement at the time. A slight air movement only is assumed.

It will be observed that the relative humidity range is from 40 per cent. to 70 per cent. and that above or below these limits we pass out of the ideal zone. Very high humidities are almost as oppressive as high temperatures, and although the point has been little studied, my own investigations show that when the relative humidity exceeds 90 per cent., at *any* temperature, there is a feeling of lethargy, headaches are common, work and efficiency suffer. It may be that the change from ideal conditions may come earlier than this, i.e. at about 75 per cent., but accurate detailed information is here lacking. Similarly, at the other end of the range, when humidity is extremely low, there is a nervous excitability and irritation observable that again militates against efficiency. Many competent British investigators have stated that a relative humidity

of from 60 per cent. to 70 per cent. is ideal, whilst the American Society of Heating and Ventilating Engineers advocates 40 per cent. to 60 per cent. as ideal, adding that 30 per cent. is 'too dry' and 70 per cent. 'too moist.' [1] So that in selecting a range of from 40 per cent. to 70 per cent. we include all American and European ideals.

It is thus seen that the ideal zone we have sketched may apply to all countries, to all peoples. It may be criticized as being too wide, for it would seem that an ideal zone should not have so great a range as 16° of temperature and 30 per cent. of relative humidity.

Nevertheless I accept it in this final form: that where indoor temperatures are above 60° F. and below 76° F. and relative humidities are between 40 per cent. and 70 per cent., men work harder and more efficiently than at temperatures and humidities outside this zone. The exact mean may vary from country to country in accordance with clothing, average yearly outside temperatures, heating systems, etc., but the limits of the ideal zone for the human animal indoors appear to be not far from those which I have indicated.

This ideal is, it may be observed, an ideal for the factory—that is to say, for light muscular or sedentary work; and in view of the fact that the United States and Great Britain lead the world in industrial efficiency we have added reasons for accepting the conclusions of investigators in these two countries. For mental activity low humidity percentages are the best, for rest and recuperation a figure approaching 70 per cent. may be preferable.[2]

[1] See Winslow and Herrington, *Subjective Reactions of Human Beings to Atmospheric Conditions*, in which pleasantness of outdoor atmospheric conditions is chiefly influenced by sunshine and decreasing relative humidity.

[2] We have admirable corroboration of these figures in Dr. E. G. Dexter's experiments, 1895–1904, in schools, prisons, banks, etc. Low humidities are accompanied by 'excessive restlessness' of mind and body in school children, by 'peculiarities of conduct' among prisoners, and by high nervous tension, insomnia, and irritability among adults generally. High humidities create apathy and listlessness. His ideal temperature range is from 55° to 70° for schools. See his *Weather Influences* (1904).

IV

THE IDEAL OUTDOOR CLIMATE

THE ideal indoor conditions have been formulated in terms of two main factors, temperature and relative humidity, with air movement as a third; but in any consideration of outdoor conditions we have to take into account not only the increasing importance of the cooling power of air movement in consequence of its greater velocity out of doors, but also new factors such as the direct heat of the sun and the different habits or activities of human beings.

One of the features of meteorological publications is that the temperature for the day, or the average temperature for months or years, for any given station is always the shade temperature. It is common experience that whilst the pleasantness associated with, say, 65° indoors may be produced by that temperature in the open air if there is bright sunshine and little breeze, it will not continue if there is no sunshine and a strong breeze, for in these conditions it will most certainly feel cooler out of doors than in. In attempting to arrive at quantitative conclusions we are faced with the following difficulties:

(1) There is a scarcity of exact data on the cooling effect of the wind, though the Pittsburgh investigators have estimated that the cooling effect of a breeze at eight miles per hour (700 feet per minute) on a man stripped to the waist, in warm weather, i.e. about 70°, is to make him feel about 12° cooler.[1] The cooling power of such a breeze is still greater at lower temperatures, but ceases altogether at temperatures over 90°.

(2) There is a similar lack of climatological data on radiation and its heating effects. Less than a dozen places in the world have accurate records over a decade of the amount of thermal energy received by a horizontal surface in the form of radiation from sun and sky. Sir Napier Shaw at Madrid in 1924 pointed out that there were then only fifty-nine places in the world for which records of solar radiation were available, and of these only eight or nine records could be considered as adequate for any consideration of the problem of its effect on human energy. It is interesting to add that the three American stations quoted (Lincoln, Madison, and Washington) show an average of over 400 kilowatts

[1] See also Vernon and Hill's investigation on these points as recorded in *The Kata Thermometer and Efficiency*.

per square decametre per day compared with 216–226 for South Kensington, Rothamsted, and Stockholm. Lourenço Marques averages 465, Toronto 291, and Pavlovsk 124.[1]

(3) On the other hand, outdoor work and occupations are usually brisker than factory occupations, but here again we have no means of assessing the difference. The man using the pick or shovel requires cooler conditions than the mechanic, the footballer requires cooler conditions than the chess-player, but it would seem as if the vast range of necessary human activities, in which, of course, we include the business of buying or selling any commodity, domestic duties, and agricultural occupations, require comparable conditions whether they be undertaken in Edinburgh or Khartoum; and whilst it is true that in the realm of sport the inhabitant of the temperate zone will be more active out of doors than the inhabitant of a warmer zone, it is also true that the conditions regarded as ideal for watching a bull-fight will also be ideal for watching a football match, as apart from playing it.

In view of these facts it is only possible to judge that, since wind and radiation tend to oppose each other (the sun gaining the upper hand near to the Equator, and the wind being much stronger than radiation towards the Arctic Circle), their variations may offset one another in climatic areas similar to those of north-west Europe.

Since, therefore, any estimate of what constitutes an ideal outdoor climate can only at best be a guess so long as our knowledge of radiation and wind power is so imperfect, we can only assume that ideal outdoor conditions will approximate fairly closely to the ideal factory conditions already stated. Taking, therefore, the whole body of the world's workers together, from the Egyptian to the Scotsman, we can assert that they will work best and most efficiently out of doors when there is a daily temperature average of between 60° and 76°, with moderate humidity, a gentle breeze, and agreeable sunshine. In conditions such as these the human being is at his healthiest, disease at its lowest, energy at its highest, and the nation that enjoys these conditions, with ideal indoor conditions, will have an immense advantage over its rivals.

We have now reached a very important point in our inquiry, for having determined the approximate ideal climatic conditions both for indoor and outdoor work, the question arises whether we can assume that any person or community of persons born and

[1] Much more information is available about hours of sunshine, which, in Europe, varies from 1200 hours per year in parts of Scotland to 3600 hours per year in Spain; but the effect of an hour's sunshine in Glasgow is vastly different from that at Barcelona.

bred in a climate between these limits, i.e. 60° and 76°, will be more energetic than those born and bred in climates whose temperatures are above or below these limits. The answer is a curious one, and it is that a person born and bred in a climate between those limits will most certainly have more energy than a person born in a warmer climate, but may not have more energy than a person born in a cooler climate.

The reason is not far to seek. Since man first mastered fire, his control of indoor climate has been growing—but mainly in the two directions of warming and drying the air. It is still almost beyond his power economically to cool or to de-humidify an average room more than a few degrees, but even the poorest families in most temperate countries can afford a building and a fire that will give them a temperature of over 60° and a humidity lower than that which prevails out of doors.

On the other hand, in climates much below these limits it becomes more difficult to control cold and to sustain indoor temperatures approaching the ideal, and less energy will consequently be available for other activities.

Therefore the ideal climate is one which, whilst never or very rarely passing the upper 76° limit, yet does not fall so low as to demand great efforts to bring indoor temperatures up to 60° or 70°, whichever is deemed the more desirable.

To put it in another form, the ideal climate is one in which men neither shiver nor perspire when at rest, it being remembered that an ideal outdoor climate is better than the best indoor conditions.

We now come to a fascinating problem which may be summarized thus: if the air conditions above stated are the best for factory work, are they the best for all types of work, and does civilization advance or decline according as man finds conditions near to or far from that ideal?

The answer is a complicated one, but for brevity's sake may be condensed into the following generalization: that the conditions which are best for factory work will produce a rising civilization provided other things are equal, and chief among these other things is clothing. It has already been said that this greatly influences feelings of comfort and energy, and we have first to consider what would be the effect of an almost complete absence of clothing.

In Egypt, in the earliest times of which we have records, we find that the garment most commonly in use was a linen loin-cloth. As time went on this developed into a sort of skirt varying in length, fullness, and folds. Later on both sexes wore a kind of shirt, and

over this a loose flowing garment which reached from neck to feet. To these garments were added sandals.[1] In ancient Sumeria, Babylonia, and Assyria, and indeed in all the early civilizations, clothing was of a comparable kind. The question is, what would be ideal external conditions with clothing much cooler and lighter than the European dress of to-day? Fortunately we have here the investigations of Houghton, Yaglou, and others working at the Pittsburgh Research Laboratories. They have estimated that a person stripped to the waist will feel from 3° to 6° cooler in the ideal range of temperature and humidity already quoted if there is a slight breeze.

Since, therefore, the clothing of all early civilizations was much cooler than the clothing of to-day, we shall not, perhaps, err greatly if we assume that whilst a temperature range of from 60° to 76° may be ideal to-day, a higher range would be required if clothing reverted again to the loin-cloth or simple shirt and skirt type. Naturally there may be some difference of opinion as to what margin should be allowed for this factor, since it is evident that once again factors other than air movement, such as radiation, have to be taken into account.

As a working generalization I suggest that a temperature range some 2° higher is required to give us approximately ideal conditions for persons lightly clad. In other words, whilst temperatures around 68° may be ideal for persons clothed and shod in European fashion, temperatures around 70° (again with relative humidities between 40 per cent. and 70 per cent.) may be ideal for persons lightly clad, and even higher temperatures for those very lightly clad.

The last point is important, for if the above inference is correct, or even approximately so, it follows that early civilizations would have had their birth and infancy slightly to the south of the 70° annual isotherm and, as clothing developed, would tend more and more to move northwards.

[1] *Introductory Guide to the Egyptian Collections in the British Museum*, p. 110.

V

CLIMATE AND HISTORY

HAVING indicated the climatic conditions under which men may develop their greatest energy, we must now see if there are any parts of the world where these conditions exist, and then see whether the inhabitants of those regions are markedly more efficient than those of less favoured regions.

It is evident, to begin with, that, prior to the discovery of heating systems, only a country that was maritime and warm could even approximate to these conditions. It is a commonplace of meteorology that the farther one goes from the influence of the sea the greater will be the daily and seasonal variations of temperature,[1] summers will be warmer and winters colder inland than at places in the same latitude on, or near, the coast.

In the second place, it is evident that climate to a certain extent can be controlled. From the time when man first mastered fire, or first began to experiment in house-building or clothing, his control over climatic conditions has been growing, until to-day one can work and play indoors at a temperature of 70° F. even in the depths of a Canadian winter, or when crossing the Equator in a modern liner. Yet mankind, in spite of heating systems, fans, and other methods of modifying the effects of temperature or moisture, is still influenced by the 'natural' climate in which he lives, for as yet his control scarcely extends beyond the walls of any building.

It must be clearly understood that a good climate and climate control are factors of primary importance not only because of the direct bodily comfort they produce, but also because of their strong indirect effect through food, parasites, and mode of living.

It is a singular irony that many of the greatest inventions that have benefited mankind were the work of men whose names and activities are unknown. The inventor of the wheel, of glass, and of a thousand other appliances and conveniences have long since been forgotten, and it is curious that almost every invention or discovery connected with man's control of climate was considered at the time of so little importance as to remain unrecorded.

[1] The greatest variations may be found at places least subject to sea breezes. If prevailing winds are from the west, then the greatest variations will be found in the east inland areas.

The Greeks, however, endeavoured to do a little justice in this direction, for to the legendary Prometheus they assigned the honour of having stolen fire from heaven for the use of mankind. From this time, until within a few hundred years before Christ, man's only protections against the climate were the clothes he wore, the buildings he erected, his brazier, and his hearth.

From the leaves of Adam to the woven fabrics of to-day, clothes have been man's first line of defence against climatic extremes. For shelter from sun, wind, or rain, for the conservation of bodily heat, the effect of clothes on human development can scarcely be exaggerated.

To a lesser extent he obtained protection in the buildings that he erected, whether of branches and reeds or of brick and tile; and to an incalculable extent heating appliances, however elementary, helped to create for him that approach to ideal climatic conditions we have already indicated.

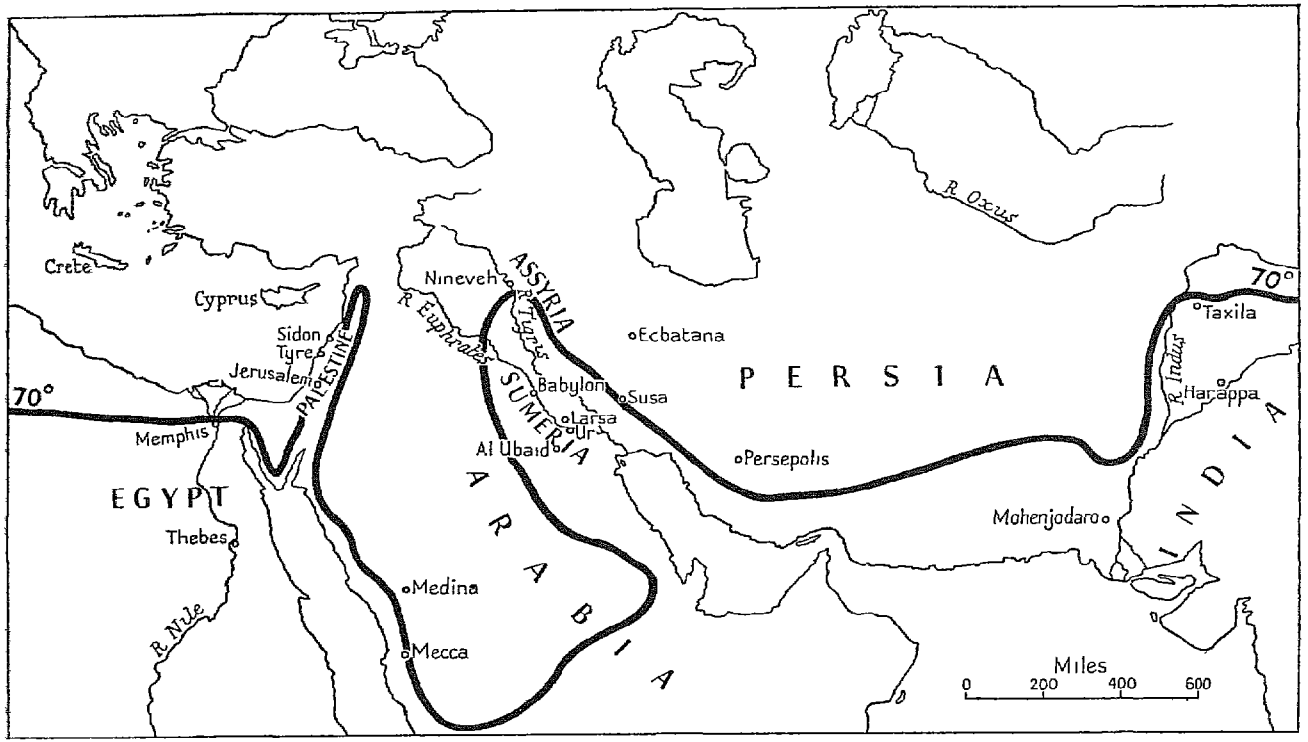
Before the invention of the hypocaust, or the fireplace and chimney, man had little control over the climatic conditions of low temperatures and high humidities, for the brazier and the hearth (unless charcoal was used) created such a smoke that the excessive ventilation needed to clear the air made it impracticable to warm a room effectively.

It follows, therefore, that prior to these developments the nearest approach to ideal conditions would be found in maritime countries with a mean annual temperature of about 70°.[1] In these areas, although winters might be chilly at night, and summers intolerably hot by day, there was always some part of the day when the demands on energy in resisting extremes would be less than in other areas to the north or south or inland.

A. THE 70° ISOTHERM

But the best climatic areas of the world will not produce a great civilization if they are continually being overrun by races from less favoured areas. Man-power is essential for the defence of any civilization, and the only maritime areas of the old world adjacent to the 70° isotherm where mankind could multiply to any great extent were the southern Mediterranean, Mesopotamia, Asia Minor, and South-Eastern China. Sumeria, Egypt, Babylon, and Assyria

[1] Over 70° would be a still better climate for men who had not perfected the arts of knitting or weaving. Thus the very earliest civilizations (Upper Egypt and Sumeria) had their origin in such warmer areas. On the subject of the development of civilization in China from the second millennium B.C. onwards see H. G. Creel, *The Birth of China* (1936).



MAP SHOWING THE 70° ISOTHERM AND THE SITES OF ANCIENT CIVILIZATION

The isotherm is shown as a line for simplicity, but it is rather a succession of areas.

all bear out this theory, for when, as a result of political developments, any one of these areas was numerically superior to its nearest rival, it held the lead. Each in turn disintegrated, and the parts fell to the greatest pressure from new unions. Is it an accident that the earliest civilizations are to be found in these regions, or that they continued there for thousands of years until a heating system superior to the brazier and the open hearth was devised? An examination of history will show that prior to 600 B.C. civilizations developed only in the fertile areas along the 70° isotherm, i.e. in the southern Mediterranean and in areas with a comparable climate.

If we trace this 70° annual isotherm we shall readily understand why so few areas of the world could have produced a civilization. Beginning with Madeira, we find that this group of islands appears to have an ideal climate if judged by temperature alone. Funchal, for example, has a mean temperature of 59° in February (the coldest month) and of 72° in August (the warmest month), and the daily temperature range is rarely more than 10°. So that here we have a climate which rarely drops below our low ideal, or exceeds our high ideal, though there are always a few days in the summer when 90° is reached, and a few days in winter when the temperature falls below 47°. It is thus a remarkably mild climate, but its very mildness is due to the surrounding ocean, which in turn produces a high relative humidity at Funchal (70 per cent.), and one even higher in the rest of the island. Thus, however delightful the climate may be, it is also conducive to indolence. Similarly the Canaries, whilst generally having a climate that is mild and healthy for the greater part of the year, not only have a high relative humidity, but are also exposed to a levante, or hot south-east wind from Africa, which is extremely disagreeable. At Santa Cruz the mean temperature for the year is about 71°, and the daily range seldom exceeds 6° F.

But although these two groups of islands have almost perfect climatic conditions, it is only in comparatively recent times that they have had a considerable population. Even to-day the population of Madeira is only 215,000, whilst that of the Canary Islands is 600,000.

Both groups of islands were known to the Phœnicians, and the Romans learned of their existence from Juba, king of Mauretania, whose account of an expedition to the islands about 40 B.C. was preserved by the elder Pliny; but it is extremely improbable that the population of either group ever exceeded 10,000 souls until comparatively recent times.

Turning now to the mainland, we have Agadir and Mogador, the most southern seaports on the Atlantic coast of Morocco, and among the best planned and cleanest towns in the French Colonial Empire. Here the mean temperature of the hottest month is about 70° F., and of the coldest month about 58° F. But one has only to go a few miles inland from these ports to find a vast change in the conditions, and along the whole of this coast there are so few fertile areas in approximately ideal conditions that it is small wonder that it has never produced a great people or great leaders.

From Morocco the 70° isotherm passes with its many involutions along the northern rim of Africa just south of the site of ancient Carthage, where one of the earliest civilizations the world has known, the Phœnician, had its greatest development. From here it runs just north of Siwa on the western boundary of Egypt. Thence to Cairo and ancient Memphis, which have average relative humidities of about 56 per cent. and monthly mean temperatures of 55° in January and 82° in July, with a daily range of approximately 20°.

From Egypt the isotherm turns due north, passing near Tyre and Sidon, which, being on the coast, have much higher relative humidities—about 70 per cent. But here again, owing to the hilly nature of this littoral, conditions change quickly. At Jerusalem and Damascus, for example, the average temperature is 10° lower, without any lessening of humidity; and the Jordan valley, as a whole, is distinctly oppressive during the summer months, whilst snow is not unknown on the hills in the winter months.

Our line [1] now runs almost due east to Baghdad and the site of ancient Nineveh, which has an average annual temperature of 73°—ranging from a mean of 49° in January to 94° in July and August. But here the great heat of the summer is modified by the low relative humidity of 37 per cent. compared with 78 per cent. in January.

From Baghdad the line runs south-east to ancient Ecbatana and slightly south of Persepolis, and then due east just south of Seistan in Persia. Persepolis has an annual mean of about 69°—ranging from 49° in January to about 89° in July, and relative humidities of 83 per cent. and 40 per cent. Our line now passes through the desert area of southern Persia until the fertile area of the Indus valley is reached. Here former centres of Indian civilizations such as Mohenjodaro, Taxila, and Harappa are to be found.

As the line runs east again we are met by growing extremes,

[1] It should be remembered that in some cases, as in Egypt, this 'line' has a depth of nearly two hundred miles, and could better be described as a succession of areas.

until north of Peshawar, with its average of 72·3°, we find a range of 40°—from 51·3° in January to 91·6° in June. Here conditions are most trying during the three summer months, when the temperature averages 90° and the relative humidity is over 60 per cent.

From North India the 70° isotherm runs down into the Indo-China peninsula, where it coincides with high humidities nearly the whole year round, and equable climatic conditions are not met with again until we reach the south-eastern part of China.

Across the Pacific the 70° isotherm cuts through the desert portions of California, then sweeps south-east through Mexico and Guatemala, and then north again into the Gulf of Mexico somewhere to the south of Galveston. Crossing the Gulf it cuts through the Florida peninsula near Daytona.

An interesting point about this 70° isotherm is that for a very great part of its course it passes through desert, or almost desert, regions. On the other hand, in the areas of high humidity, such as Burma and Indo-China, through which it passes, singularly little civilization appears to have developed. Thus it is that regions such as Mesopotamia and the Nile valley became the homes of early civilizations, for whilst they could not compare with the mildness and healthiness of places such as Mogador, they favoured energy more than did the humid areas of Burma or Indo-China. Moreover, they could sustain a population of many hundreds of thousands, perhaps millions, even with the archaic agricultural methods then in vogue. But the very fact that they had not an ideal climate all the year round meant that the civilization would be slow in development, and easily checked by a few years of unfavourable weather. A change of 5° or more in the average temperature for a period of years might mean the movement of any civilization that then existed to a region perhaps a hundred miles farther north or farther south as the case might be.

But where the 70° annual isotherm does approximately coincide with moderate humidities and with cultivable areas, as at Carthage, Memphis, Antioch, Nineveh, Babylon, Persepolis, and Ningpo, and in Mexico, Peru, and Guatemala, we find that early civilizations —the Phœnician, the Egyptian, the Assyrian, the Babylonian, the Persian, the Chinese, the Aztec, the Inca, and the Maya—had their origin and development.

This is, perhaps, the first fact in the history of civilization, that it had its birth and early stages in the well-populated fertile areas adjacent to the 70° annual isotherm. For thousands of years Egypt, Mesopotamia, and Persia led the world in the long progress

from barbarism to culture, and the lesser areas, such as Crete, Cyprus, and Malta, where early civilizations flourished, are all areas adjacent to the 70° isotherm. At the same time, it cannot be too strongly stressed that the 70° isotherm is not stationary. From year to year it varies—and possibly from age to age. Meteorologists tell us that climate has variations in 1400-year cycles from 'dry-warm' periods [1] to 'cold-wet' periods. If there is anything in this theory, it follows that southern Egypt at some time and Crete at another time may have had climates nearer the ideal than northern Egypt.

B. EGYPT AND INDIA

The written records of Egypt begin about 4200 B.C., when it is stated that the country was invaded by a people of great artistic ability from the Red Sea area. This in itself is a most important fact, for it indicates that prior to the rise of Egypt the world's budding civilization was located farther south, which agrees with the theory already propounded. From 4000 B.C. to 300 B.C. Egypt led the world, but not continuously, for time after time it was invaded, time after time vigour seemed to give place to enfeeblement.

Historians and archæologists tell us that Egyptian civilization begins around 4200 B.C., that around 2800 B.C. was the age of the pyramids and other grand constructions, that around 1400 B.C. was another great period (the Eighteenth Dynasty), and that a final burst began under the Ptolemies about a thousand years later when Egypt became again 'the dominant State in the Mediterranean.' It is remarkable how each of the periods and their intervening eras of lassitude or decay correspond to the climatic pulsations above indicated.

But, more than this, we find that other civilizations emerge at the time of favourable climatic conditions. India is warmer than Egypt and it is, therefore, to be expected that her periods of greatness would occur during the 'cold-wet' periods about 4200, 2800, and 1400 B.C. It is interesting to find that Sir John Marshall, the great Indian archæologist, has charted the last two of these periods with some exactness. The Mohenjodaro civilization, with its 'lively intercourse between the Indus valley and the Elamite and Mesopotamian sites,' occupied the period between 3250 and 2750 B.C. From this period to 1500 B.C. India was constantly invaded, but then, as Dr. J. H. Hutton says:

Meanwhile in the extreme east of India other movements were going on, as there was a widespread race movement of the southern Mongoloids

[1] See in particular H. W. Clough's recent work in this field published in the

southwards to the Bay of Bengal and into Indonesia, which had some reflex influence on India from the east. Finally about 1500 B.C. came the Indo-Aryan migration into the Punjab, which first occupied the area between the Indus and the Jamna and later sent colonies across the Jamna into Hindustan. These imposed themselves upon the surviving civilization there, which so reacted to this powerful stimulant as to produce from the combined material the philosophy, religion, art and letters that were the glory of ancient India.

We cannot, of course, postulate with any accuracy as yet the effect of climate on history in such remote periods, but there is a possibility that with every extending investigation into 'sun-spots' and other phenomena we may reach more precise conclusions regarding weather fluctuations over long periods and their effects upon history.

Egypt and ancient Mesopotamia had one further great advantage over any other areas in that the comparative levelness of their territories, and the fact that their populations were each distributed along navigable rivers, combined to give them rapid means of intercommunication, and consequently the establishment of unified kingdoms. These advantages were not possessed to any degree by the peoples of the Iranian plateau, which, possibly because of the presence of mountain ranges and the consequent difficulties of travel and communication, remained split into many tribes and minor kingdoms, whilst Egypt and Babylon had achieved their great historical unities. It was not until the coming of Cyrus that these tribes were first welded into a single nation, and they rapidly became one of the foremost people in the world.

It is interesting to note that the Median Kingdom, one of the most powerful of these earlier States, had been founded about 720 B.C. by Deioces, who selected Ecbatana as its capital. The modern Hamadan built near the site of this ancient city lies almost on the 70° isotherm. Cyrus became king of Persia in 553 B.C., and seven years later he defeated the combined forces of the Medes, Egyptians, Lydians, and Spartans. By 546 B.C. Sardis had fallen, and during the succeeding twenty years, under Cyrus and his son Cambyses, the Persian power advanced to the Mediterranean, conquering in turn Babylon, Chaldea, Syria, Palestine, and Egypt. The cause of this astonishing success, which in the brief space of a single generation raised a previously secluded tribe to the mastery of the Orient, has been attributed to its military superiority under the great leadership displayed by Cyrus, Cambyses, and Darius, but even Herodotus emphasizes as part of the cause of its success the fact that it was domiciled in a healthy climate and was 'of all

mankind the readiest to adopt foreign customs, good or bad.' And we know that in the list of the things which pleased Alexander the Great two centuries later was the splendour of the baths of Darius, which suggests some knowledge of heating methods.

Moreover, the Persians conducted their wars with great humanity and utilized to the full the ablest of those whom they defeated. The ground was prepared for that amalgamation of the Iranians into a single uniform nation, which was completed under the Sassanids. We have no accurate information regarding the climate of Pasargadæ where Cyrus built his capital, or of Persepolis built by Darius somewhat more inland, but a computation of climates of neighbouring towns enables one to estimate their temperatures as averaging 70°, with comparatively low relative humidities. The greater part of Persia consists of the great Iranian Plateau, which rises to a height of 4000 to 8000 feet and contains within this area a few well-watered regions through which the 70° isotherm now runs. Thus, for example, Shiraz has a mean annual temperature of 65° and Kazerun a mean of about 73°, and it was near Shiraz that Cyrus established the new capital of Persia known as Persepolis. Darius succeeded to the throne in 521, and among other indications of the intellectual audacity of these Persians was the canal that he made from the Nile to the Red Sea; and it was he and his son Xerxes who subdued and conquered all enemies to the east, south, and west. But their successors could not withstand the growing might of Macedon, and in 333 Alexander, by defeating the Persians at Issus, overthrew the Achæmenian Empire. For the next few centuries the history of Persia is overshadowed by that of the Hellenistic kingdoms, which, in spite of internal disunity, managed for a time to avert any great catastrophe.

C. GREECE AND ROME

For the first time in history the leadership of civilization left these regions along the 70° annual isotherm, and passed to one in which a means of controlling cold had been discovered that was superior to the open fire or brazier. Apparently the Lacedæmonians were the first to discover such a means, for to them is attributed the discovery of the hypocaust system of heating, in which the floors, and later the walls of buildings, were warmed by the passage of hot air through flues.[1] This discovery and its development

[1] Dr. Stanley Casson tells me that the Ionians may have been the inventors of this form of central heating, and that at Ephesus the great temple was centrally heated by lignite.

naturally gave the wealthy among the early Greeks an indoor climate that could be effectively controlled in all but the hottest months, and it is, perhaps, significant that the leadership in culture did not pass from the 70° isothermic area until it was transferred to Greece.

The recent history of western nations teaches us that the adoption of climatic control by any country leads to greater prosperity and greatly increased numbers. If we assume that Greece began the hypocaust system about 750 B.C. and that Rome adopted it a little later, we are struck by the same phenomena, for although the population of Greece was never high relatively to its area, the excess, as Gibbon points out, had emigrated as colonists or mercenaries. How great this excess was may be gathered from the number of Greek colonies established about 700 B.C. from the Black Sea to Marseilles; one city alone, Miletus, planting about ninety such colonies. In the following centuries colonizing ceased, but Greek mercenaries are found by their tens of thousands, even in the Persian and Indian armies opposed to Alexander the Great, and in the half-century following Alexander's death Carthage employed a Greek general and Greek mercenaries to defeat Regulus. It is amazing to think that the glory of Greece was founded on a total population of about 300,000, of whom 120,000 were slaves, 20,000 resident aliens, and only about 165,000 free citizens and their families.[1]

It is, perhaps, only too obvious that whilst such a civilization as the Greek might by constant invention defeat its less civilized foes, even when numerically superior, it would fall quickly before any great aggregation of peoples enjoying an equal civilization.

From Greece the hypocaust system had passed to Persia and Rome. But neither the Greeks nor the Persians developed heating systems as did the Romans, who quickly became the world's supreme plumbers and heating engineers. The houses of the wealthy had central heating, windows were glazed, and water was generally laid on. Just before the Christian era warm public baths became common both in Rome and other Italian cities. Mæcenas was one of the first who built public baths at his own expense, and from the time of Augustus successive emperors, seeking public favours, spent great sums in constructing enormous buildings which contained not only baths, but also gymnasia, and sometimes even temples, music rooms, theatres, and libraries. They were popular lounges, used by rich and poor alike for rest and recreation. The

[1] Gibbon, *Decline and Fall*, World's Classics edition, i, pp. 307 et seq.

technical skill displayed by the Romans in the construction of these *thermæ* was of the highest order; the walls and side reservoirs were rendered impervious to water, and the flues for the conveyance of hot air through the walls were of superb construction. These *thermæ* were open from 1 P.M. till dark, and the charge for admission was a quarter of an *as*, less than half a farthing.[1] Yet cheap though this was, the emperors sought and found still greater popularity by making the baths at times free to all. Some idea of the popularity of these 'stately palaces' may be gathered from the fact that the baths of Caracalla at Rome had 1600 seats of marble, and that this was but the largest of 800 public baths in Rome alone.

Let us consider what this meant to the average inhabitant of an Italian city. The wealthy, of course, had their own heating arrangements, but the mass of the people could go to the baths in the middle of the Italian winter (which at Rome meant an average January temperature of about 44° F., assuming no great climatic change, and at Milan an average January temperature of about 34°) and there find, for a trifling sum, warmth and entertainment for several hours. Perhaps the best comparison is to imagine the population of an American city sweltering in the summer heat, from which they have little protection in their own homes, enabled to go to air-conditioned offices, workshops, or cinemas and there working, or being amused and perhaps instructed, in a cool atmosphere which promotes energy and counteracts the debilitating effect of the natural climate outside.

It is, perhaps, not beyond the bounds of possibility that in the case of the Romans and of the Americans this relief helped to produce a more energetic race. We know that the Romans themselves laid much store by their heating systems, for wherever they went—north, east, or west—they built, of brick and tile, houses so substantial that some have lasted to this day. As far north as the Roman Wall we find these elaborately designed houses, where the Roman leaders could be as free from cold or damp as any of their modern successors. At Woodchester, near Stroud, a Roman villa of the time of Hadrian (A.D. 117–138), covering an area 180 yards by 100 yards, had over 60 rooms, most of which were heated by hot air, distributed from furnaces through terra-cotta tubes; whilst at every Roman military station of importance there were similar buildings, many of which have yielded up their secrets to the pick and brush of archæologists.

In addition to the hypocaust system, the Romans also used

[1] Gibbon, *op. cit.*, iii, pp. 359–60.

portable stoves and coal-tubs, specimens of which have been discovered in Pompeii. In warming apparatus of this kind the fuel used was charcoal, or dry wood, as producing the least smoke. Whether the Romans had chimneys or not is a disputed point. The usual opinion is that the smoke was not drawn off by means of a flue, but by openings in the roof, windows, and door; but the use of flues was not unknown to them, and even real grates have been discovered in the ruins of ancient buildings at Pompeii. Chimneys are to be met with there only in baths and bakehouses; but in Rome and North Italy they were used also in dwelling-houses, at least in the days of luxury and refinement.[1] In the most ancient times little was known of chimneys, so that the old *atria* were often disfigured with smoke; but the lodging and working rooms soon began to have both grate and chimney, though the chimney was not high enough to cause a good draught. It may be added that wood and charcoal were the only fuels known to the ancients suitable for indoor purposes. Rome thus developed her control of cold and damp to a point never previously reached by any people, and in addition to this she had the great advantage of a large population.

Where Greece had been limited in her scope by the small number of her citizens, Rome, from the first junction of the Romans and Sabines to the final extension of the franchise by the emperor Trajan about A.D. 100, admitted all the inhabitants of conquered States to the privileges of Roman citizenship. These newcomers showed their gratitude by almost unwavering loyalty. By contrast, Carthage, like the Greeks, confined privileges to its own citizens, and found that defeat stripped it of its allies.

We have seen that the Greeks, superb in civilization as never a people before, at the period of their great prosperity could number only 165,000 free citizens, but Rome even in the time of Paulus Æmilus (168 B.C.) could count on 337,000 citizens capable of bearing arms. Under Caius Gracchus in 122 B.C., the admission of Italian allies swelled the numbers of Roman citizens to 4,163,000, and the extension of the franchise to the Gauls augmented them to 6,900,000.

Similarly, whilst Greece chose her leaders from her limited numbers of citizens, Rome could and did choose from a far wider field. Other things being equal, numbers will tell, and when the finest, and most energetic and most cultured city-states the world has ever seen came into conflict with the sheer weight of Rome, Rome won.

[1] W. A. Becker, *Gallus*, p. 279.

In the same manner Carthage was destroyed, and for several centuries from 150 B.C. Rome remained mistress of the known world.

The surprising thing is that Rome should have allowed its superb heating systems and baths to deteriorate. As we have seen, a good climate, indoor or outdoor, helps to produce an energetic people, and the Romans were certainly energetic in these *thermæ*. These not only provided opportunities for hearing lectures, for exercises and business transactions, but also favoured unbounded licence. Thus when Rome became Christian under Constantine in 323, and again in 363 under Jovian—this time permanently—the early Fathers of the Church roundly condemned attendance. They wrote that bathing might be practised for cleanliness or health, but not for pleasure; and by the fifth century many of the large *thermæ* in Rome and other cities fell into decay, and with them the 'luxurious' habits of heated houses. Great was the power of the Church of those days.

Gibbon's account of the mental attitude of these early Fathers is interesting:

> [They] despised all knowledge that was not useful to salvation, and, vainly aspiring to imitate the perfection of angels, they disdained, or affected to disdain, every earthly and corporeal delight. . . . The unfeeling candidate for Heaven was instructed, not only to resist the grosser allurements of taste or smell, but even to shut his ears against the profane harmony of sounds, and to view with indifference the most finished productions of human art. Gay apparel, magnificent houses, and elegant furniture were supposed to unite the double guilt of pride and of sensuality. . . . In their censures of luxury, the Fathers were extremely minute and circumstantial; and among the various articles which excited their pious indignation [was] the use of warm baths.[1]

Constantine not only gave the Roman Empire a new religion, he gave it a new capital, and the spread of Christianity, carrying with it a more ascetic mode of living, was coincident with the removal of practically the whole of the wealthy or courtly population of Rome and other cities of Italy. The transfer of the seat of government of the Empire from Rome to Constantinople was begun in 324, and in less than a century Constantinople disputed with Rome for pre-eminence both in riches and numbers. It was asserted, and believed, says Gibbon, 'that all the noble families of Rome, the senate, and the equestrian order with their innumerable attendants had followed the Emperor to the Banks of the Propontis . . . and that the lands of Italy long since converted into gardens

[1] Gibbon, op. cit., ii, p. 40.

were at once deprived of cultivation and inhabitants.' It is easy to see that such an event must have carried in its train the decline of the larger houses of Rome and the decay of the hypocaust system of heating.[1] It is from this time onwards that Gibbon notes the growing laziness of the Romans, their reluctance to undertake military service, the enrolment of Barbarians and their promotion to generalships and consulships. The fertile and happy province of Campania, within sixty years of the death of Constantine, was converted into desert and uncultivated land. 'As the footsteps of the Barbarians had not yet been seen in Italy, the cause of this amazing desolation, which is recorded in the laws, can be ascribed only to the administration of the Roman emperors.'[2] Yet neither Constantine nor his immediate successors were as bad administrators as Caligula, Claudius, or Nero, and Gibbon records again and again the relaxation of discipline and the growing laziness and indifference that had become characteristic of the people of Rome prior to the onset of the Barbarians.

Civil wars, protracted until 353, were the prelude to the Barbaric invasion of Gaul. Gibbon points out that these invading races, from Tartars to Huns, had developed a system of trekking north for the summer, and south in winter[3]—thus in their own way modifying their climatic extremes, just as wealthy Englishmen used to go to the Riviera in winter and Scotland in August.

Thus whilst Rome was losing its methods of climatic control and its families who had benefited by them, the Barbarians were becoming ever more numerous and vigorous. In 410 Rome fell to Alaric; in 455 it was plundered and pillaged by Genseric, and was in a state of utter decay by the year 600. Thenceforth Italy was divided into a dozen petty States.

But the fall of Rome did not extinguish the civilization of the ancient world. For a time Athens continued as a centre of learning, and even when the Emperor Justinian in 529 closed down the ancient schools in the Greek capital, Constantinople kept alive for several centuries the knowledge of the past. But in Constantinople, as in Greece, the learned Christian was preoccupied with theology, and the Greek interest in science and philosophy for their own sakes was almost dead. Medicine was well cultivated in Byzantium and there seem to have been a few small additions to the knowledge of the ancients, but substantially Byzantine laymen were content to

[1] Possibly the growing shortage of wood also had something to do with the abandonment of the hypocaust system.

[2] Gibbon, op. cit., ii, ch. 7, p. 220.

[3] Gibbon, op. cit., iii, ch. 26, p. 89.

copy and comment on their forerunners without much attempt at originality.[1]

The sack of Constantinople by the Crusaders in 1202 almost put an end to the Greek culture which still continued there. There survived, however, the manuscripts of the Greek authors which, after the fall of Constantinople to the Turks in 1453, were to set western Europe alight with learning.

It is interesting to note that Constantinople is month by month about 3° F. cooler than Rome, but there is little evidence that the Romans who migrated to Constantinople built houses on the same system as in Rome, i.e. with the hypocaust system of heating. Gibbon and Bury are silent on this point but they both point out that whereas Rome had 800 public baths, Constantinople, even a century after its foundation, had only eight. If the building of private houses with the hypocaust system was in the same proportion there would have been a significant difference in the control of indoor conditions between the two empires.

It is perhaps more than a coincidence that the rise of Greece and Rome should follow the advent of heating systems and that the fall of the Roman Empire should follow their abandonment. A stranger coincidence still is that with the decline of Rome and the decay or neglect of heating systems in Europe, world power should pass back to the warmer countries lying along the 70° F. isotherm.

D. ARABIA AND ISLAM

From A.D. 500 to approximately 1300 Europe, excepting only the southern Mediterranean fringe and Constantinople, endured the long depression of the Dark Ages, and fell back on earlier types of domestic architecture and heating. The arts of brick- and tile-making were forgotten or never learnt by the Barbarian and were unknown to the Saxons and Normans. The only type of heating was, once again, the open fire. It is significant that during this period civilization in Europe halted in its spectacular progress and returned to south-east Asia and the southern fringe of the Mediterranean. While Europe shivered, the people of the Near East shook off the last relics of Roman overlordship and once again became the conquerors.

With the decline of the power of Rome in the fifth century, which, as we have seen, was preceded and accompanied by the destruction or neglect of the heating devices that were of such

[1] Sherwood Taylor, *A Short History of Science*.

service during the winter months, the central point of power gradually passed back to those areas which had been leaders of civilization prior to the Greek and Roman Empires—that is, to the countries south and east of the Mediterranean and in the area formerly known as Sumeria.

But before we turn to Egypt and Sumeria we must consider again the eastern Roman Empire, for unlike the western Empire this did not fall to the Goth, Hun, or Vandal, but remained an independent and, indeed, a powerful state for several centuries. Constantinople was the most populous centre the world had probably yet seen.[1] Its superb position, easy of defence, preserved it many times from attack. But this city, with its climate a few degrees cooler than that of Rome, was seldom the united capital of a united empire. Religious discord led to strife. Constantine's successors varied from pompous fools to the meteoric and superb Julian, silver-tongued and adventurous, and to Justinian the Great, who ascended the imperial throne in 527. A great law-giver, a great builder, a great theologian, and a great conqueror, his standards went in triumph to Italy, the Levant, and Northern Africa. Yet under him an insurrection resulted in the burning of the city and the loss of 80,000 lives. The cathedral of St. Sophia, beautiful baths, and other buildings were raised upon the ruins, and wealth and prosperity returned, in spite of Hun and Vandal. Constantinople was mistress of the eastern world. 'Constantinople,' wrote Finlay in his *History of the Byzantine Empire* (1854), 'was as much superior to every city in the civilized world in wealth and commerce, as London now is to other European capitals.'

Justinian's successors were tyrants, drunkards, and madmen until Heraclius came—only to be faced with the usurping power of the Arabs. There was a brief return of culture and prosperity under Basil I, and then an era commencing with a rebellion by the great nobles of Asia and ending, to quote Finlay, 'when in 1203 a band of 20,000 adventurers, masked as crusaders, put an end to the Roman Empire in the East.'

Meanwhile, about A.D. 230, Persepolis became once more the capital of the Persian Empire, but it was not until long after the decline of the Roman power, in 531, that Chosroes raised the empire to a condition of prosperity which it had long failed to reach, and compelled the Byzantine Justinian to pay him tribute. About this latter date the Persian capital was transferred to Al-Medain

[1] Sozomen in the fifth century described it as far surpassing Rome both in riches and in population.

(Ctesiphon), a few miles from ancient Babylon and the more modern Baghdad. But Persia, besides suffering from the long and exhausting wars with the eastern Roman Empire, was stricken with civil war from time to time, until from 627–631, as Gibbon tells us, 'in the space of four years the royal title was assumed by nine candidates who disputed, with the sword and dagger, the fragments of an exhausted monarchy.'

At this period there arose a religious power that for the first time in history united the Arab tribes under a single banner. Arabia is, on the whole, one of the hottest regions of the earth, especially along the coasts of the Persian Gulf and the southern half of the Red Sea, but in the interior, in northern and central Arabia, the nights are cool, and the winter is fresh and invigorating, while on the highlands of Yemen, Asir, and Oman, the summer heat is not excessive, and the winters are, comparatively speaking, cold.

Here there are two areas—the neighbourhood of Medina and that of Mecca—where the climate is a little better than in the rest of the territory. At Mecca in A.D. 560 or 559 Mohammed was born. Long before his birth the Arab world had reached a high level of civilization. Writing was a fine art, and poetry, oratory, and eloquence were held in general esteem. Architecture was advanced, and the Arabs were masters at building wells and storage tanks, and there are still remains of castle and city walls that existed centuries before the Mohammedan era. Mecca itself, possibly on account of its sanctuary, had long been a great centre of commerce and free from the shedding of blood.

Why is it that this strong, dignified people should suddenly shake off their inertia and become the makers of a great Saracen Empire, carry a religious creed half across the world, disseminate scientific knowledge, and then sink back, a spent power, into their desert? Possibly the initial cause was that Mohammed provided a religious doctrine to which all Arab tribes could, and did eventually, adhere. His immediate successors at the head of a united aggregation of peoples carried the banner of the Prophet far beyond the confines of Arabia, particularly Omar who, within ten years of Mohammed's death (634–644), added Syria, Iraq, and Egypt to the Islamic empire. Under Othman (644–656) Afghanistan, Turkistan, Armenia, and Khurasan were brought under its sway.

The Arabs, thus emerging from their desert homes, became the aristocracy of Islam. Conquered nations, even of much higher civilization, when they reached the faith fell into an altogether lower caste.

. . . This ascendancy, social, military and political, the Arab maintained for upwards of two centuries. Then they were gradually supplanted throughout the East by Turks and Persians. . . . But in Spain and Africa the prestige of Arab blood survived.[1]

Under Mohammed and his immediate successors the tribes of Arabia were united in one faith. Those who were disaffected were crushed or expatriated. Successful expeditions into Syria and Mesopotamia not only provided booty for all the tribes, but also additional wives. With such a trinity of incentives—the religious, the mercenary, and the voluptuous—small wonder that the Arab forces went from victory to victory.

In 641 Egypt was added to the Arab dominions. The province fell after a campaign lasting only a year, apparently surrendered by the eastern Roman Emperor without any great attempt to vindicate the former renown of Roman or Greek arms.[2] The land was left in the hands of the previous owners, and became the granary of Arabia, as it had been the granary of the Roman Empire.

The Arabs were thus the champions of Islam—soldiers and nothing else. They might not settle down in any of the conquered lands as cultivators, while for commerce or other civil occupation, warlike life offered little leisure. They lived on the fat of conquered provinces. Under Omar the income of the commonwealth was divided as heretofore amongst the Faithful, but henceforward according to religious merit or military service. Wives, widows, and children too had their stipend, and every Arab soul was rated at what it was worth. A whole people subsidized by spoils on the basis of equal brotherhood is a spectacle without parallel in the world. Martial genius was maintained by the rewards offered. The nation was an army mobilized, with promise of a never-ending stream of recruits, for whilst none but Arabs could form part of this ennobled soldiery, the whole progeny of the Arab sire, whatever the mother, was Arab. Arab women as a rule married only Arab husbands, but the other sex were free to contract marriage with the women of conquered lands, and the children, whether the mother were slave or free, Muslim, Jew, or Christian, were equal in legitimacy and equally Arab.

How productive this system was may be gauged by the fact that

[1] Sir William Muir, *The Caliphate: Rise, Decline, and Fall*, p. 44.

[2] At the time of the conquest, Alexandria was the second city in the attenuated eastern Roman Empire—a seat of commerce, luxury, and letters. The vast population of this city, well over a million, was provided in unexampled profusion with theatres, baths, and places of amusement; according to Muir, there were possibly 4000 baths and 400 theatres (Sir William Muir, op. cit., pp. 159 et seq.).

one of the early Arab generals, Khalid ibn Welid, lost forty of his sons in the plague of 639.[1] 'We shall not greatly err,' says Muir, 'if we assume that before Omar's death the Arabs beyond the limit of Arabia proper numbered half a million, and before long were doubled and perhaps quadrupled.'

But as yet the Arabs were in no sense a civilizing force. Apart from war and faction, Muslim life gradually became idle, inactive, and sanctimoniously voluptuous. In the greater cities intemperance and libertinism began to spread, checked only by the hallowed associations of Medina, which encouraged a severe simplicity of life.

In the early part of the eighth century, within a hundred years of Mohammed's death, north-western Africa, southern Spain, and north-west India were added to Islam—which in each case was aided by troops from the invaded areas. Inroads were made into France—assisted by disloyal chiefs of the invaded country, until the victory of Charles Martel at Tours in 732 placed a check on the expansion of Islam.

Meanwhile the capital of the Arab Empire, which had been at Mecca until 657, was transferred to Al Kufa, and from there, under different dynasties, to various cities in Iraq and Syria, Damascus and Baghdad being among the more important, and it was in these centres, and not until this period, that a civilization began to develop. As Buckle says, in his *History of Civilization*, 'In Arabia they had been a mere race of wandering shepherds; in their new abodes they became the founders of mighty empires—they built cities, endowed schools, collected libraries; and the traces of their power are still to be seen at Cordova, at Baghdad, and at Delhi.'

During the whole of its first hundred years Islam had been a religious, but not necessarily a civilizing, force. Beyond the Koran they added little, while they destroyed much. With the rise of Persian influence, however, there opened an era of culture, toleration, scientific research, and luxury. The ancient lands of Babylon, Assyria, Egypt, and Carthage bred a race of warriors, scientists, and missionaries equal to those of any earlier time. Scholars from the East held high and influential place, while the Arabs, who had ever looked with contempt upon nations every way their superiors in science, art, and culture, now were fast learning from those whom they had despised.[2] Literature, history, medicine, and especially astronomy began to be studied, and practically all the knowledge

[1] Muir, op. cit., p. 145. [2] *Ibid.*, p. 465.

of medicine and mathematics, geography and applied sciences, and astrology reposed for several hundred years in Baghdad, Damascus, and Cordova. The culture of Baghdad was mainly due to the people of Persia and Khorasan, as well as in some degree to the more liberal intercourse with the Greek Empire. Within fifty years of the founding of the Abbasid dynasty in 750 the court of the Caliph had become the centre to which from all parts flocked the wise and the learned, and at which rhetoric, poetry, history, and law, as well as science, medicine, music, and the arts, met with a genial and princely reception—all of which bore ample fruit in the succeeding reigns.[1]

Arnold Wood points out that while Europe sat in darkness Baghdad became the centre of a splendid civilization. Mohammedans and not Christians became heirs to Greek culture, especially in respect of geographical knowledge. Ptolemy remained unread by Europeans until the fifteenth century, but already in the ninth century his books were translated into Arabic, and inspired a native Arabic science, which in turn in the thirteenth century was accepted by Roger Bacon. By the ninth century observatories were founded at Baghdad and at Damascus, and a school of geographical science was formed. Arabian travellers co-operated with men of science and surveyed every sea from Spain to China, Cairo to Madagascar, from Java to Canton. Even the Indian Ocean, as Sir William Hunter said, 'became an outlying domain of Islam.'

Thus, as in the case of Greece and Rome, civilization centred again in the midst of the greatest aggregation of people enjoying for the time the nearest approach to ideal conditions. The neglect of heating systems and the consequent loss of control of indoor conditions by the Greeks and Romans, or their successors in various territories, meant that the focal point of civilization would again move south until that control was renewed. The Arab hegemony gave way to the suppleness of the Persian, and the Persian in controlling the Arab Empire controlled it from the site of previous civilizations. The pendulum of civilization after having been pinned to the north for a thousand years had, after a few oscillations, swung back to the points where it had been before the hypocaust had been invented, i.e. in the fertile areas along the 70° isotherm.

In the absence, throughout the world, of any heating or cooling systems, the peoples of Sumeria, with its twin rivers the Tigris and the Euphrates, or Egypt with the Nile, enjoying a bearable (but by

[1] Muir, p. 486.

no means perfect) climate, were bound to lead. But if either of these regions were partitioned or distracted by internal feuds, or other causes of trouble, then leadership might well pass temporarily to Syria, Persia, or Carthage. But a united Sumeria or Egypt, in an age before artificial heating was adopted, was the inevitable centre of civilization in the old world.

E. SPAIN AND PORTUGAL

But now the Arab Empire, which had spread over much of the area previously occupied by Rome, began to break up. Faction had always been rife, and the history of the Arabs is a record of constant internal faction and rebellion. The fervour of religious enthusiasm had diminished, and self-aggrandizement had taken the place of passion for national glory and extension of the Faith. The Saracen was no longer the conqueror of the world.[1] The Caliphate was no longer co-extensive with Islam nor dependent upon the Arabs. The Abbasid dynasty (750–1258) was dependent upon levies from Persia and Khorasan, and gradually Turks from the Oxus, barbaric and savage, acquired high positions in the army. Spain became a separate state of Islam from about 750; Idris established a separate dynasty at Tangiers a few years later; while in the East, as time rolled on, other independent dynasties arose.

It may be thought strange that Spain, lying in the same latitude as Italy and Greece, should have contributed so little to civilization until this period, apart from a brief period of distinction under the influence of Rome.

But from the time of the Romans, Spain, like Italy, had been carved up by Goths into a series of petty states, each warring with the other until, in 711, the country was overrun by the Moors under Musa and Tarik, aided by Count Julian, the chief of one of the noblest families in Spain and a warrior of renown, at the head of 10,000 men.

In southern Spain, which as we have seen has a climate comparable to that of Egypt,[2] the Moors multiplied until Spain could boast a larger population than any other comparable Mediterranean area. In the middle of the tenth century, when Europe at large touched the lowest depths of the Dark Ages, the southern part of Spain displayed perhaps the most brilliant civilization since the days of Pericles. Under Abd-el-Rahman III (912–961) a patient

[1] Muir, op. cit., p. 433.

[2] Seville has a mean annual temperature of 68° ranging from 52° to 85°, Cairo has a mean annual temperature of 70° ranging from 55° to 83°.

and skilful agriculture, superb craftsmanship, and the most honourable commerce in the world, created a wealth and prosperity that was without its parallel. It is noteworthy that both in the construction of houses and baths this territory then led the world. The population of this southern half of Spain was then about 30 million. But the civilization that might have continued to flourish here was kept in check for 750 years whilst the tide of war between Moor and Christian surged backwards and forwards—now with the Moors bursting into France, now with the Spaniards regaining even Gibraltar. Not until 1462 were the Moors finally ejected from Gibraltar and southern Spain.

Almost at the same time Spain became united under Ferdinand and Isabella. Ferdinand, heir to the throne of Aragon, and Isabella, Queen of Castile, were married in 1469, and a few years later the two kingdoms, so often at war with one another, were united, and Spain now represented the greatest aggregation of peoples under a single ruler within the Mediterranean area. Italy was still a bewildering patchwork of medieval states, Islam was split into a dozen fragments, and nowhere in the Mediterranean was there a people so united or so ably led as the Spaniards at this period. Within two generations from the first voyage of Columbus, in 1492, Spain had extended her dominions from the Netherlands to Peru. The world had never seen a larger or richer empire. Portugal too was at her zenith, and her empire was second only to that of Spain.

But half a century later, in 1594, the first Spanish census gave a population of only 8,206,791, compared with 30,000,000 under Abd-el-Rahman III about 950.

The figures are remarkable enough as indicating the loss of status that may befall a country through a decrease in numbers. The decimation that the wars with the Moors could not produce was brought about by American expeditions, the Inquisition, and warfare both at home and abroad.

The Spanish *conquistadores,* at once brave and ingenious, begat few children in their own country, but many half-castes in South America, thus leaving Spain grievously deficient in great men, while such of these as did remain could scarcely hope to escape civil war or murder. The fields of Spain were untilled, towns were deserted, and whole populations starving. To add to the decline, decrees in 1609–10 expelled from Spain the industrious descendants of the Moors, and half a million of her best citizens were hounded out. During the next century civil wars and foreign wars continued until, under the profligate Philip IV (1621–65) and the semi-idiot

Charles II (1665–1700), Spain was stripped of power, prestige, and resources. It succumbed to nations not numerically stronger, but employing better methods of climate control.

F. CIVILIZATIONS IN AMERICA

While Europe was thus awakening from the torpor of the Dark Ages there were developing in America three civilizations that have aroused the interest of the world—the civilizations of Mexico, Peru, and of the Guatemalan highlands.

America was probably first inhabited some ten or fifteen thousand years ago, the first immigrants apparently arriving from Asia by way of Bering Strait and Alaska, either in boats or across the ice. Almost certainly there was no mass migration, possibly hundreds of years elapsing in some cases between the crossing of one group and that of the next. These first immigrants were on a very low cultural plane, probably resembling in this respect middle or late palæolithic man in Europe. Wearing skins for warmth, they hunted game with spears and lived either in caves and rock-shelters or in very primitive shelters erected in the open.

By degrees, these immigrants and their descendants spread all over this vast continent from the frozen north to the temperate coastal strip of California and the Mexican plateau, and to the steaming Amazonian jungles and the sub-antarctic Tierra del Fuego.

America is a continent of marked physical contrasts. In the same latitude one can pass from arid coastal plains across snow-clad peaks into tropical jungle. Within a distance of three hundred miles one finds these overwhelming contrasts of sandy waste and impenetrable jungle teeming with life. Travelling from north to south the transition is less abrupt, but varies from the frozen spaces of northern Canada to the tropical deserts of northern Mexico, from the steaming jungles of Brazil and the woodlands and swamps of Paraguay, to the treeless pampas of the Argentine and down into south Patagonia and Tierra del Fuego, a region of sub-antarctic flora and fauna. America thus presents the extremes of heat and cold, of desert, forest, and jungle. Somewhere within its limits every type of vegetation can be found.

The contrasts in civilization are as marked as those of physical geography. On the one hand the areas adjacent to the 70° F. isotherm have nurtured the most advanced civilizations of the new world; on the other Tierra del Fuego is still the home of some of the most primitive tribes in the world.

Here again we may note that, as in the old world, the gradual

development from barbarism to civilization began and flourished in territories not far removed from the 70° F. isotherm; but in this vast continent only a few small areas have an equable climate all the year round, mostly on the sides of the mountain ranges that skirt the west coast. Everywhere else either the ranges of temperature are great, or heat, cold, or humidity are excessive. Prescott, the great historian of the Aztecs and the Incas, lays stress upon the salubrious climate of the areas that formed the head-quarters of these peoples. Speaking of the Aztecs, 'a poor, but wandering tribe, a fierce and brutal race,' which, owing to an oracle, settled in the valley of Mexico, he says:

'This valley is situated at an altitude of 7500 ft. and has a circumference of about 200 miles, and in those days contained five large lakes of much greater area than they are to-day,' as Humboldt states.[1] The point is important since these vast lakes would have a modifying effect on the climate. 'This tableland enjoys,' says Prescott, 'a mean temperature not lower than that of the central parts of Italy'—i.e. 62. 'In the time of the Aztecs the tableland was thickly covered with larch, oak, cypress, and other forest-trees, which again would have a modifying influence on the humidity of the area.'[2]

To-day Mexico City has a mean annual temperature of 60° F., ranging from a monthly mean of 54° in December to 65° in May, and the relative humidity varies from 47 per cent. in April to 71 per cent. in September. Thus of all the regions of the world where the climate may be considered as kindly to man, this, with possibly an even smaller temperature range some hundreds of years ago than now, owing to the geographical changes mentioned, was one of the best.

Gradually the Aztecs conquered all adjacent territories until their empire comprehended the country between the 14th and 21st degrees of latitude North, and their lake-island capital, founded in 1325, attained the first rank in the western world.[3] Prescott notes that when the three states in this area, Mexico, Tezcuco, and the smaller Tlacopan, formed a league under the leadership of Mexico, a rapid increase of population ensued, together with the mastery of the whole region. They created 'the nearest approach to civilization to be met with anciently on the North American continent.' 'The history of the Aztecs,' Prescott continues, 'suggests some strong points of resemblance to that of the ancient Romans, not only in

[1] *Atlas Géographique de la Nouvelle Espagne* (1811), i, p. 334.
[2] *History of the Conquest of Mexico*, i, p. 9.
[3] Prescott, op. cit., ii, p. 233.

their military successes, but in the policy which led to them' (i, 18). 'The degree of civilization which they had reached, as inferred by their political institutions, may be considered, perhaps, not much short of that enjoyed by our Saxon ancestors, under Alfred. In respect to the nature of it, they may be better compared with the Egyptians; and the examination of their social relations and culture may suggest still stronger points of resemblance to that ancient people' (i, 35). 'It is a further proof of civilized habits that the Spaniards found barbers' shops, and baths, both of vapour and hot water, familiarly used by the inhabitants' (i, 291). Their homes were well built, but had neither windows nor doors, hanging mats being used for the latter purpose.

This civilization fell before Cortés and his Spaniards. They created in its place a barrenness. Mexico City is now three miles from the water, and the lakes have been drained.

In comparing the Aztec and Inca civilizations Prescott says, 'Both nations commenced their career of conquest at dates, it may be, not far removed from each other. And it is worthy of notice that in America the elevated region along the crests of the great mountain ranges should have been the chosen seat of civilization in both hemispheres.'[1] He traces the source of the Inca civilization to Cuzco, which became the worthy metropolis of a great and flourishing monarchy. Like Mexico City, Cuzco enjoys a genial and salubrious temperature, and is not far from the present 70° annual isotherm. From this centre, 'under the mild and benevolent sceptre of the Incas, a community gradually extended itself along the surface of the broad tableland, which asserted its superiority over the surrounding tribes.' In the fifteenth century Chili and the powerful kingdom of Quito were added to the Peruvian empire. Here an industrious population had settled along the lofty regions of the plateau, and towns and hamlets clustering amidst orchards and wide-spreading gardens seemed suspended in the air far above the ordinary elevation of the clouds. This region—i.e. the plains of Quito—is at a height of between 9000 and 10,000 ft. above the sea.

Like Mexico, Peru fell before the Spaniards, and Pizarro fixed the new capital at Lima only six miles from the sea, but not comparable with Cuzco for salubrity of climate.

There is one further American civilization to be considered, that of the Mayas in Yucatan, an area which at first sight might seem to be outside the 70° isotherm. But a closer review of the history of

[1] *History of the Conquest of Peru*, p. 97.

the Mayas reveals the fact that their civilization started in the Central American highlands almost along the line of the 70° isotherm, and that when it had attained its highest point the people removed to less congenial climatic areas, and that here, within a comparatively short space of time, their civilization, after a last flowering, decayed.

The region (see Map, p. 64) in which their civilization developed and declined is divided to-day between Mexico, Guatemala, British Honduras, Honduras, and San Salvador, but if we view it as a physical unit we can divide it roughly into two main areas—the lowlands and the highlands—the lowlands being adjacent to the sea coast and including also Campeche and Yucatan, and the highlands covering the more southerly portion. Near the coast the climate is distinctly unhealthy, with malarial fevers very prevalent. The Atlantic coast has a further disadvantage of a heavy rainfall and high humidity, and there is a local saying at Golfo Dolce that it rains thirteen months in the year. On the highlands, however, the climate is healthy, and the differences in temperature may be seen from the following table:

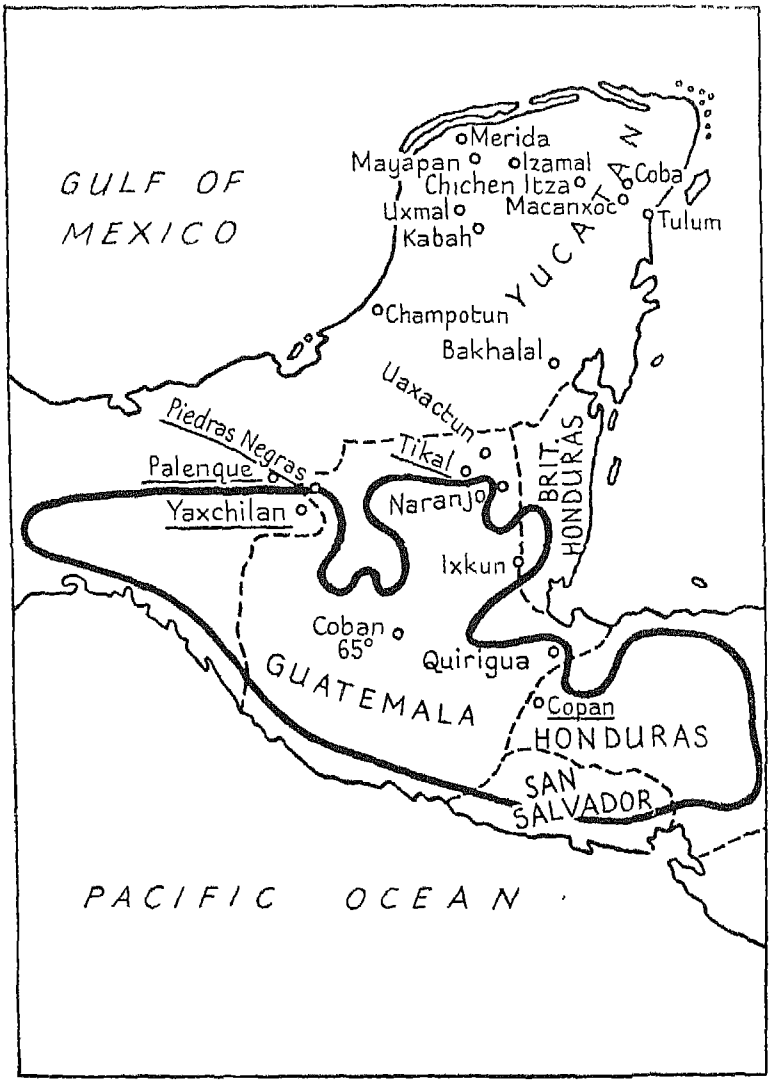
Locality	*Altitude* (*feet*)	*Mean Temperature of* *January*	*May*
Puerto Barrios	6	74	81
Salama	3020	68	77
Campur	3050	64	73
Chimax bei Coban	4280	61	68
Guatemala	4870	61	68
Quezaltenango	7710	50	62

(May is the hottest month)

Unfortunately, we have no accurate meteorological maps for this region, but if we take the above table, combined with the figures available for several Mexican towns, we get the 70° F. annual isotherm in the position indicated on the map. Here again it is remarkable that this should cut through nearly all the sites where the Mayan civilization began and developed.

According to J. Eric Thompson,[1] the earliest known Maya city is Uaxactun, in the northern Peten district, which dates from about A.D. 300. Excavations have revealed evidence of a very long occupation. Other important early Maya cities, all dating from the fifth century, are Copan, Tikal, Yaxchilan, Piedras Negras, and Palenque. Tikal is famous for its great extent as well as for

[1] *The Civilization of the Mayas.*



THE MAYA AREA WITH PRINCIPAL CITIES

The thick line indicates approximately the 70° isotherm, and the underlined towns are those where the Mayan civilization had its birth and achieved its greatest heights.

the great height of the pyramids erected there. Yaxchilan and Piedras Negras reached a higher level in the sculpture of stone than any other Maya city. Palenque is famed for its low-relief tablets with their simple lines and exquisite work in stucco. Copan, on the other hand, was the intellectual centre of the Mayas, for here the greatest advances in astronomy and mathematics were made. Nevertheless, Copan art and architecture were not unworthy of her rivals.

In the sixth and seventh centuries a large number of cities or religious centres came into prominence, of which Quirigua, Naranjo, and Coba were the most important. The art of these cities was, with few exceptions, distinctly provincial, falling far below the best work of the cities founded earlier.

This was a period of unexampled prosperity, and the population must have been very dense. The dwelling houses, which were made of wood, thatch, and adobe, have crumbled into ruins, leaving no trace behind, but the many cities with their innumerable artificial mounds, palaces, and temples must have demanded the labour of a hugh population for their erection, especially as only stone tools were used.

Just as Athens was crushed at the height of her power, so the Maya empire was destined to fall within a century of her greatest period. In the middle of the eighth century, one by one these proud cities ceased all civic activities. One or two, such as Tikal, continued to flourish for a time, but by A.D. 890 the last city of the Old Empire had ceased to erect stelæ and elaborate edifices.

Many theories have been brought forward to account for this cessation of activity. The view has been advanced that the Mayas were forced to evacuate territory owing to pressure from Mexican invaders. It is very doubtful that this was indeed the main reason. If the Mayas abandoned their territory in face of the invaders from the north, it would be only natural to expect that the Mexican arts and crafts would be discernible, but such is not the case.

It has been suggested that wasteful methods of agriculture made conditions harder and harder for the Mayas in the old territories and that eventually city after city had to be abandoned owing to the exhaustion of the surrounding soil. This would have resulted in an annual decline of production, which continued until famine stared the inhabitants in the face.

The Maya system of agriculture was primitive. Land suitable for agriculture was prepared by burning off the trees and undergrowth. After the first rains, the sower, armed with a bag of seed and a sharp-pointed stick, crossed and recrossed the field, making a hole with his stick in the ground at every pace, and throwing a few grains of maize

nto the pit. At the end of the season the field was abandoned, and next ear the Maya farmer marked out a new piece of land to be cleared and own. In the course of time, and with the large increase of population hat undoubtedly occurred, the Mayas must have been driven farther nd farther afield in search of virgin soil. The exhausted soils nearer ome must have been resown after shorter and shorter periods of re- uperation. In time the yield of the district would have fallen below he level of consumption and, faced with the alternative of evacuation r starvation, the people chose the former.

There are other theories to account for an actual exodus of the whole opulation from the Old Empire region, among which pestilences and limatic changes figure. Actually it would seem that this whole area ontinued to be occupied long after the religious centres fell into eglect. It is not improbable that the governing priest class was over- hrown by a revolt of the masses.[1]

Most of the tribes now moved north, and the Itzas around A.D. 711 arrived at Chichen Itza and there constructed edifices which for size and decoration were far superior to those of the earlier civilization. At the end of the century the Itzas abandoned he city and moved across to Champotun on the west coast, where hey lived in peace for a period of 260 years. About 20 years after he Itzas had settled at Champotun, another tribe known as the Xius moved into Yucatan and settled at Bakhalal. After 60 years' esidence at this spot they moved to Chichen Itza, which had re- nained unoccupied since its abandonment by the Itzas. Here hey remained a further hundred years until, as the native accounts ryptically state, 'Chichen Itza was destroyed.' The Xius then proceeded to Champotun, where, attacking the Itzas, they drove hem from the city and settled there themselves (A.D. 1145).

About A.D. 1260, Chichen Itza was reoccupied by the Itzas with Mexican aid. Probably the Itzas had come into close contact with Mexicans during their stay at Champotun. The Maya dark ages were over, the renaissance was at hand. These perpetual shiftings that had lasted almost four hundred years had had a drastic effect on Maya civiliza- tion; the art which had been the glory of the Old Empire had suffered a blow from which it never recovered; the sculptures of Yucatan never reached the high level attained in the ninth cycle. . . .

Influences from Mexico had undoubtedly made themselves felt at Chichen Itza considerably earlier than this first mention of them in the historical outline. There is reason to believe that Mexicans reached Chichen Itza at the time the Itzas returned to their old capital and the league of Mayapan was established (about A.D. 1260). These Mexican invaders probably hailed from the area bounded by the modern states of Puebla and Vera Cruz, and were probably of Toltec affinities, both cultural and racial. They were instrumental in introducing a new

[1] Thompson, op. cit.

religion, a new art, and possibly new methods of warfare. Apparently, they established their rule at Chichen Itza, and the profound influence they exerted can be seen to this day in the large number of beautiful palaces, temples and colonnades they caused to be erected.[1]

For a time this striking civilization continued to flourish, but in the middle of the sixteenth century came the Spanish invasion. The Mayas put up a stout but ineffectual resistance, and within a few decades the Maya civilization had vanished.

It is, perhaps, strange that the territories, Mexico, Cuzco, Quito, and the Guatemalan highlands in which these American civilizations grew should all be areas most congenial to men climatically, in the absence of any climate control. Had any of them been capable of supporting a population comparable to that of Egypt or Italy, or had they been occupied a few centuries earlier, history might have taken a very different course.

CHINA

Meanwhile there had been developing in China civilizations in some measure comparable with those of Sumeria and Egypt, though by no means equalling that of Greece. Here again it is noteworthy that the early centres of Chinese civilization were slightly to the north of the 70° isotherm. Possibly the higher humidities in China rendered slightly lower temperatures more congenial, but the social history of China still has to be written, and we know so little of Chinese heating methods (beyond the fact that stoves were in use by the inhabitants similar to those now used by Russian and Polish peasants) that it is impossible to give her cultural development in any detail. But we do know that China had been using coal for centuries when Marco Polo visited the country in 1275 and brought back our first information about its teeming millions.

G. THE COAL CIVILIZATIONS

We have thus seen that, apart from the Greek and Roman civilizations, every civilization up to the fifteenth century was centred in an area not far removed from the 70° F. annual isotherm. When this period was reached, however, some four or five developments had taken place which changed the face of the world, and removed the focal centres of civilization from the 70° F. isotherm area to countries much cooler.

As early as the thirteenth century significant changes in arts

[1] Thompson, op. cit.

and appliances were helping to mould the future—the rediscovery of brick-making, window glass-making, and coal, and the invention of the fire-place and the chimney. About this time the art of brick-making had been discovered afresh in Flanders, and gradually the use of bricks and tiles spread until it became general in many parts of Europe. The oldest brick house in England, Little Wenham Hall in Suffolk, dates from the thirteenth century. Simultaneously the glazed window became common, a further means of controlling cold and damp.[1]

Prior to this brick and tile period, the hearth was in the centre of the room, and a hole in the roof let out the smoke. Obviously, with walls made of wood and dried clay the fire could not very well have been anywhere else, but with the central hearth and the roof lantern to let out the smoke most of the heat generated by the wood fires of the period would escape—and only the wealthiest could afford continual fires.

It may be well, perhaps, to endeavour to imagine the conditions under which people in this country tried to work and think prior to the development of the 'sealed' house. The people of Britain numbered then (in 1400) about 2½ millions—and they lived for the greater part in buildings that would compare with the wooden farm-barn of to-day. When the Romans left, their towns and superb central-heated villas were sacked or neglected, and the Britons, Saxons, and Angles made wooden or wattle huts thatched with straw, reeds, heather, or whatever was handy—clay or mud being used to stop the gaps. Glass and coal were unknown. We read that even Alfred the Great, who twice visited Rome, and was determined to raise the level of his own people, found that when he came to work by candle-light 'the draught that blew in through the door and windows, through the chinks in the walls, or through the slits of tents, made the candles burn unevenly.'[2] The Norman barons were, perhaps, a little better off in their castles, but the average dwelling remained the same for centuries. A countryman's house even as late as the time of Queen Elizabeth is thus described:

> Of one bay's breadth [16 feet] God wot, a silly cote,
> Whose thatched spars are furred with sluttish soote
> A whole inch thick, shining like blackamoor's brows
> Through smoke that down the headless barrel blows.

[1] Glass was known and used in Egypt in 1740 B.C., but the earliest windows in Europe are those in the church of Saint-Denis, France, twelfth century. It came into extensive domestic use in England about 1550. The Saxons were fine glass-makers, but I have found no evidence of their using glass for windows.

[2] Williams, Ellis, and Fisher, *History of English Life*, p. 92.

But with brick and mortar there came the significant development of the fire-place and the chimney, and shortly afterwards that of the grate and the use of coal.

It was these three innovations, the chimney, the grate, and the use of coal, combined with new developments in architecture, which changed the whole history of mankind. Unfortunately, history is almost silent on the origin of the chimney and the grate. Possibly the earliest chimney-piece known in the world is in the King's House at Southampton, which is attributed to the first half of the twelfth century,[1] but another Norman house, at Boothby Pagnell, Lincs, disputes the honour. We know that at Rochester Castle (1130), at Colchester Castle, at Conisbrough Castle, and at Hedingham, Essex, there were fire-places in the twelfth century, but no external chimney shafts, the flue being carried through the wall at 10 or 15 feet above the hearth. It was not until about 1340 that the first modern chimney shaft was made—a most important development, which had its origin in Italy or France, as we shall see later, and apparently spread to England about 1450.

Wood and charcoal were still the common fuels for the large open fires of this transition period, and for the support of the burning logs iron bars, or andirons, were employed; these, by raising the wood from the hearth, allowed a freer circulation of air around it, and so occasioned an accelerated combustion. The hearths were wide, with massive beams of wood to support the heavy canopies, and in their deep recesses great fires were built up, around which the lords and their retainers could gather.

Let us now see how the Renaissance, or the 'revival of learning,' is related to this. It took its rise in northern Italy in the fourteenth century and was primarily a study of the writings of the great classic authors. It is interesting to note that it was in this area that the fire-place and chimney apparently first developed. A Florentine document, *Cronichetta di Memorie famigliare di Neri degli Strinati*, refers to a fire-place built in the thickness of a wall in Pisa in 1300, and there is also mention of a similar construction two years later.

The chronicler, Giovanni Musso, writing of Piacenza, affirms that before 1320 chimneys did not exist in this city: '. . . there was then no chimney in houses because then they made only a fire in the middle of the house, under the dome of the roof, and all of the said house stood around the said fire, and there the

[1] It is interesting to note that the first time the word chimney is used in the English language is in the decade 1330–40, when it was used to denote a fire-place or hearth, or a 'turret flue'. See *Oxford English Dictionary*.

cooking was done.' His later chronicles, however, describing the same city in 1388, mention that chimneys had, during the intervening years, been built in many houses.

It was in Lombardy and Tuscany that the more rapid development took place, as in those two States fire-places came into more general use, not being restricted to the houses of the nobles. In 1364, in Florence, a fire-place was constructed in the refectory of the Ospedale di Gesu Pelegrino.[1] In 1368 Francesco da Carrara, a Paduan prince, 'on making a journey to Rome took with him masons who constructed a chimney in the inn at which he stayed because in Rome they did not then use chimneys and all lighted the fire in the middle of the house on the floor.' This statement is borne out by the fact that by the end of the fourteenth century in Florence fire-places began to be constructed in all rooms instead of one single fire for the whole house.

Further proof of the general use of chimneys in northern Italy can be found in Dr. Margaret Fishenden's *House Heating*, where she says (p. 14 et seq.):

> Their use was frequent in Italy in the fourteenth century, for an inscription found in Venice states that in 1374 a number of chimneys were overthrown in an earthquake. Some doubt attaches to the exact meaning associated with the early use of the word, which was probably synonymous with 'hearth' or 'fire-place.' Flues carried right up the walls of the house appeared later; the earlier ones were generally circular in section and consisted of a single flue with smoke apertures in the side of the summit or louvre. During the fourteenth century ornamented chimneys appeared, the chimney and the shaft itself frequently being treated as the important architectural features.

Thus, by the beginning of the fifteenth century fire-places had become common in northern Italy, and during this century the multiplication of the fire-places led to the grouping of several flues inside a vertical and generally rectangular mass of masonry carried well above the roof. In Italy these chimneys were utilitarian and were hidden whenever possible. The fire-places and mantel-pieces, however, were lavishly decorated.

It is, perhaps, only another coincidence that the greatest improvements in heating and warming methods since Roman times should have originated in an area which, within a comparatively short time from the date of their general adoption, gave birth to the Renaissance.

This great outburst of civilizing thought received a powerful stimulus from the fall of Constantinople in 1453, which caused the dispersion of Greek scholars from Byzantium, carrying their manu-

[1] Turner, *Domestic Architecture* (1851), Introduction, p. 17.

scripts with them. But a hundred years earlier than this there had begun that thirst for the new learning in northern Italy which rendered so popular the lectures of Emanuel Chrysoloras, who had come over from Byzantium in 1396 and was soon followed by others, greatly encouraged by Cosimo de' Medici (1389–1464).

This blaze of art and learning soon spread to the neighbouring lands, as did the twin developments of the fire-place and the chimney; but countries to the north and west had this advantage over northern Italy, that where she could only control her winter climate, Germany, Switzerland, Holland, France, and England could control indoor temperatures throughout the winter, spring, and autumn. By 1500 the Netherlands and the adjacent territories were the richest and most urbanized areas of Europe. Antwerp, indeed, could now be regarded as the hub of civilization. Erasmus, Holbein, Dürer, the Van Eycks, Memling, Grotius, Grocyn, Linacre, More, Colet, Ascham, and Camden, and scores of other great humanists, testify to the great advance that civilization made in this area during this period, and they were rapidly succeeded by Marot, Montaigne, Rubens, Van Dyck, Bacon, Shakespeare, and Marlowe, and others whose fame has echoed round the world.

In this great upsurge that now began, Britain, though its climate is so cold and damp as to be a byword for inhospitality, had one advantage which was eventually to give her the lead over many rivals apparently more favourably placed—the possession of illimitable supplies of coal fuel.

When we consider that coal is to be found in every continent of the world, and particularly in Britain, Germany, France, Belgium, the Netherlands, Poland, Czechoslovakia, Russia, India, Japan, South Africa, the United States, and Australia, each of which countries now produces over ten million tons a year, it is remarkable that its utility for so many purposes was neglected until this period. Theophrastus in 200 B.C. knew of coal in Liguria and in Elis, where it was used by smiths; but the first documentary evidence of acquaintance with coal in England is found in A.D 853, in the Saxon Chronicle of the Abbey of Peterborough. Axes and picks, however, of considerable antiquity, found embedded in coal seams in various districts, testify to the early use of this commodity. Cinders are also frequently met with among Roman remains in this country.[1]

[1] It is recorded in Collingwood Bruce's *Hadrian's Wall* (1933 edition) that when the Roman fort at Housesteads, near Hexham, in Northumberland, was excavated by Mr. Clayton in the middle of last century 'nearly a cartload of coals' were discovered in one of the turrets there. This coal is believed to have been obtained from an outcrop near by.

In 1180 systematic mining was carried out, and by about the middle of the thirteenth century coal may be regarded as having become a commercial product. For a century or two the domestic use of coal was restricted to burning with wood, as at Jarrow monastery from 1313 onwards; it was not used alone on account of its smouldering tendencies on the hearth fire, and because of its unpleasant odour.[1] It is easy to see that without adequate draught not only would the coal not burn well, but that the resultant smokiness must have been most unpleasant.

As early as 1273 the burning of 'sea cole' was prohibited in London because of its smoke, and in 1306 a citizen was executed for contravention of this law, but the eventual development of fire-grate and chimney-shaft removed the objectionable smell, and by 1540 coal-burning, draught-proof houses, with windows instead of slits, were generally adopted throughout the middle and upper classes in England, in spite of petitions to Parliament that the importation of coals into London from Newcastle should be prohibited.[2] The first exports of coal to France were made in 1325.

Parliament, however, could not stop the consumption of coal, and by 1546 we find Henry VIII ordering 3000 chaldrons for use in France, and in 1577 Harrison's *Description of England*, a prefix to Holinshed's *Chronicles*, records that 'coal mines are so plentiful in the north and west of England as to supply the whole of England with fuel. The use of coal has grown from the forge into the kitchen and hall, and is a check to the waste of wood burning.'

In 1555, for instance, we find the Venetian ambassador to London reporting that 'in the north of England they find a certain sort of earth, well nigh mineral, which burns like charcoal and is extensively used, especially by blacksmiths, and but for a certain bad odour which it leaves would be yet more employed as it gives great heat and costs little.'[3] The price was then about five shillings a ton at Newcastle.

This new method of heating proved so popular in England that by this time almost every village had chimneys. William Harrison, the above noted clergyman, writing in his delightful *Description of England*, speaks of the great progress of the period. 'Old men yet dwelling in the village where I remain,' he says, 'find

[1] Archer, *History of the Coal Trade* (1897).

[2] As late as the seventeenth century we find the City of London petitioning Parliament to suppress the 'anusance of Newcastle coals in regard to their stench.'

[3] Archer, op. cit.

things "marvellously" altered within their sound remembrance, . . . one is the multitude of chimneys lately erected in each village, whereas in their young daies there were not above two or three but each one made his fire against a reredos in the hall.' The 'sealed' house, with its glazed windows, fire-place, and chimney, had come to stay.

The production of coal at Newcastle increased rapidly from 190,000 tons in 1602 to over 1,000,000 tons in 1650. Gray in his *Chorographia or a Survey of Newcastle upon Tyne* (1649) relates that

> coal in great abundance is carried into most parts of England southwards and into Germany and other transmarine countries. Many thousand people employed, which trade of coal began not fourscore years since. Coales in former times was only used by smiths and for burning of lime; woods in the south part of England decaying, and the City of London and other cities and towns growing populous, made the trade for coale increase yearely, and many great ships of burthen built in one year than was in seven yeares forty yeares by-past; this great trade hath made this part to flourish in all trades.

The deep fundamental importance of this change is so remarkable that it cannot be over-stressed. The nations of north-west Europe now had the means of mitigating the severity of their winters. No longer was man's energy during the long winter months absorbed in resisting climatic extremes, for the warm comfort within doors gave them conditions almost as good as their southern neighbours were enjoying out of doors.[1]

Britain with her re-discovery of coal and her vast coal deposits now began to lead the way in this new indoor civilization, but the Netherlands, northern France, and Germany were swift to follow where they had previously led. Neither Spain nor Portugal, Venice nor Genoa, could resist the advance, for in accordance with the great fundamental law we have already indicated, civilization has a greater chance of developing where the climate, indoors and out of doors, is most suitable for man's activity. The vital point is this: men could now control cold and damp, for as the coal fire, in an iron grate and with a proper chimney, warmed the air, it dried it in a way that the hearth fire with the roof lantern could never do. To give an indication of what this means let us take an average January and July in London. January's average outdoor temperature is about 38° F. and the relative humidity about

[1] At the same time there was a parallel development in clothing; coarse woollen clothes were introduced into England in 1191, and were first made at Kendal in 1390. Their use became general within a few decades. Linen, an Egyptian discovery, was first made in England in 1253.

80 per cent., but indoors the figures are about 64° and 50 per cent. wherever effective heating methods are used. In fact it may be said that indoor conditions in January in England are better for work than outdoor conditions in July and August. Control over dampness is as effective as control over cold. But man was still unable to control heat or dryness. The burning days of a Spanish or Italian summer could not be modified as could the cold damp days of northern Europe, and as north-west Europe throve, Spain and the cities of Italy began to decay.

Gradual modifications in the design of the domestic fire-place accompanied the constantly increasing use of coal, for the burning of which the large open hearths and irons of the old wood fires were found totally unsuited; but owing to the lack of transport facilities, wood still remained the common fuel in rural districts, and in 1800 the total consumption of coal of the kingdom for all purposes was still under 11 million tons. The latter half of the nineteenth century, however, saw a remarkable development of canal navigation, and coal soon began to find its way into new districts and rapidly became the general household fuel of the nation. By 1869 the total home consumption of the United Kingdom had risen to over 65 million tons, of which no less than 18½ million tons were absorbed for domestic use, and over 6 million tons by gasworks.[1] In 1913 the total consumption figure was 189 million tons, probably about 36 million tons of this being burned in the raw state in domestic grates, and 18 million tons utilized by the gasworks. In 1938 total British production was 227,000,000 tons of which 36,000,000 tons was burned in domestic grates, and 36,000,000 tons exported.

These figures reveal the astonishing fact that of the entire coal consumption for all purposes, including factories, iron and steel industries, mines, railways, and gasworks, about 19 per cent. is absorbed in its raw state for the warming of our houses, and almost invariably also for the polluting of our atmosphere, and the defacing and destruction of the building materials, decorations, and fabrics with which the smoke comes into contact; yet the problem of successfully and economically warming buildings is, as a science, still only in its infancy.

Gradually this coal civilization spread, aided after 1800 by gas lighting and heating, and after 1830 by kerosene, steam heating and hot-water systems. The stove and the furnace added to man's control of cold and damp. In every art and science, in every field

[1] 'Report of First Royal Coal Commission' (1871).

of exploration and discovery, north-west Europe now made vast strides. The Industrial Revolution was one of the striking developments of this period. Coal made power. Moreover, the mental energy required to develop industrial power and machinery was assisted through indoor climate control which permitted all the year round application to difficult problems.

Europe had the mastery over all the continents, and the white man bestrode the world like a Colossus. He imposed his will on Asia and Africa; he planted his settlements and colonies in the most favoured parts of the earth; and where he could not settle he seized control of the mineral wealth and raw materials. Great Britain profited greatly by these new conditions.

The development of North America was an equally important result. Here for countless centuries had been some of the most fertile land in the world, but its exploitation had been checked at every point, save along the Pacific coast, by the grave drawback of climatic extremes only equalled by those of Central Asia. At Chicago, the Red Indian predecessor of the modern American had to contend with temperatures that fluctuated from a monthly mean of 24° F. or less in winter, to 73° F. in the summer; yet Chicago was one of the more fortunate areas since it lay on the shores of a vast lake which modified extremes. At St. Paul, Minneapolis, the range was still greater—from 12° to 72°, and in the heart of the land, away from the Great Lakes, from Winnipeg to Santa Fé, and from Salt Lake City to St. Paul, Minneapolis, the monthly range was over 60° from winter to summer, from well below freezing-point to a heat that was almost unendurable.

Into this land poured the energetic men and women of the coal civilizations, British, French, Dutch, German, and Swede. Some went north to what is now New England and Canada, others south to New Orleans or Charleston. They had equal chances. Yet in the south, where the heat of the summer was well above the ideal maximum, their civilization declined. Not only here, but in the West Indies, in South Africa, in every warmer zone where these multitudes of Europeans settled, the 'poor white' problem appeared. In the colder zones, on the other hand, such as New England and the Great Lakes area, and in those portions of the American continent where the climatic range is small and approximates to the ideal, as along the Pacific coast, European civilization took on a new life, a new energy.

All over the world this stream of European emigration spread, bringing with it the habits of the well-built house, the coal fire, and

oil or gas lighting.[1] Wherever this stream reached the warmer lands it lost its vigour. In India and the Sudan the British found that only by frequent periods of leave, and by constantly replacing their soldiers, administrators, and officials, could they retain their hold. The whites could overrun the world, but they could not people the world. Whenever this coal civilization came into conflict with peoples of a warmer area, it gained decisive victories. The British conquest of India, the conquest and partition of Africa, the war between the U.S.A. and Spain, all tell the same story: victory was ever to those peoples whose home was in a climate that could be controlled.

In the last two centuries nothing has been more spectacular than the rise of the U.S.A. and the decline of Spain. In 1776, when the United States came into existence as a distinct nation, Spain could boast the largest empire the world had known. Her dominions stretched from Louisiana to Chile, and included the Philippines, Cuba, Haiti, and a score of smaller colonies. But we have already seen that while other nations were increasing in numbers and adopting methods of climate control, Spain had a stationary population and, perhaps most important of all, failed to develop climate control to any considerable extent.

By contrast the U.S.A. advanced rapidly both in population and in climate control. In 1790 her total population was under 4,000,000, by 1898 it was over 71,000,000; whereas Spain had only increased her population from 10,500,000 to 18,000,000 in the same period, and had already lost the greater part of her American empire. Thus when Spain and the U.S.A. met in war in 1898 it is not surprising that the former was decisively defeated in the short space of sixteen weeks.

Part of the U.S.A.'s great accession of strength was due to immigration, but the gain of the U.S.A. was the loss of other countries. It has been estimated that in the nineteenth century the U.S.A. received no less than 50,000,000 immigrants.[2] The American 'Homestead' Law of 1862, which gave 160 acres to every immigrant citizen-head of a family, acted like a forced draught to a furnace already burning well. In the next 40 years 14,000,000 (mostly British and German) migrated from Europe to the U.S.A., and over 2,000,000 to Canada, of whom many crossed the border and became U.S. citizens. From 1850 to 1913 no fewer than

[1] Electricity for lighting and heating may be dated from Green and Staite's first patent for electric light in 1846, but it was another half-century before its use became general.

[2] Rossiter, *A Century of Population Growth* (1909).

18,000,000 people left the British Isles to take up a permanent residence in North America. Prior to this great wave there had been 1,000,000 paupers in England (1842), and in Ireland famine 'stalked like a spectre through the land' as a result of the failures of the potato crops during the years 1845–47. When crops failed, rents failed, and when rents failed, landlords evicted tenants, to emigrate or to die: they died in their thousands, but they emigrated by tens of thousands. History may be searched in vain for a parallel to so extraordinary an exodus of the human race in so short a time. From 1846 to 1855 over 1,812,000 Irish men and women emigrated. From 1842 to 1895 the population of Ireland, despite a birth-rate of 26 per 1000, decreased from 8,300,000 to 4,600,000.

A similar movement, but on a smaller scale, occurred in Germany and other European countries during the latter half of the nineteenth century and the opening decade of the twentieth century; the stream of emigration began with the crushing of the revolution of 1848. In the next 20 years 1,380,000 Germans emigrated to the United States, a movement which only slackened when the vigorous economic policy of the new German Empire showed its people how to live at home. Italy, Austria-Hungary, and Russia, in the decade immediately preceding the War of 1914–18, each sent over a quarter of a million emigrants *yearly* to the U.S.A. alone.

But this great stream was dammed early in the twentieth century. Immigration practically ceased with the War of 1914–18, for in 1924 the U.S.A. closed her doors to unrestricted immigration, and other countries (notably the British Dominions) followed suit. In some of these countries, such as New Zealand, the depression of 1930–32 caused a reversal of the tide of immigration.

It is interesting to consider of what type these emigrants were. The generally accepted view is that they were of the best and most adventurous stocks, but some of those who migrated from Europe to America were men who, in their own country, had fallen behind in the race. The Irish farmer or English artisan who emigrated often represented the less successful type of his own class, and those who moved on again to the 'frontier' were those who had not met with much success in the region nearer to the Atlantic. Few men who have won a good position by grit or skill desire to emigrate; those who cannot succeed in the struggle at home emigrate if they can. Natural selection, therefore, may sometimes be on the side of those who remain at home. 'A migration as a rule,' Huntington says, 'is merely a slow drifting of people with unusual energy and initiative from unfavourable to favourable districts.' Is it not

sometimes a slow drifting of those below the standard of competition in their own country to countries where the competition is thought to be less fierce? Again, the successful emigrant occasionally returns to his own country, the unsuccessful rarely does so.

Whilst emigration has, therefore, been a powerful factor in building up the numerical strength of the U.S.A., the British Dominions, and the Argentine during the last century, it is rapidly declining as a nation-building force.

Birth-control has replaced emigration as the means of limiting population in a restricted area; indeed it may now be urged that it is far more effective, and in several countries of north-western Europe the birth-rate is so low that it is extremely doubtful if present populations can be maintained. In France, Esthonia, Sweden, Belgium, Germany, Lithuania, Switzerland, and the United Kingdom the rate of natural increase (i.e. excess of births over deaths) is now less than 5 per 1000 per annum. Fertility rates have halved, and the number of potential mothers is fewer than 20 years ago. This is also true of other countries in which the urban industrial civilization of modern times has been highly developed. There is also a falling tendency in countries less highly industrialized.

Thus pressure of increasing numbers as a factor in national economy no longer operates in the following countries:

	Population 1933 *in thousands*	*Excess of Births over Deaths per* 1000 *population per annum*	
		1921–30	1931–35
France . . .	41,880	1·75	0·8
Austria . . .	6,750	4·8	0·9
Esthonia . . .	1,125	2·6	1·6
Sweden . . .	6,212	5·4	2·5
United Kingdom . .	46,538	6·45	3·3
Belgium . . .	8,248	5·95	4·0
Latvia . . .	1,940	6·6	4·4
Switzerland . . .	4,125	6·25	4·6

France, owing to her relatively high death-rate compared with that of other civilized countries, actually registered decreases in 1929 and 1935, while Austria and Esthonia have each recorded a decrease for one year.

In France, Austria, Esthonia, and Sweden, therefore, unless there is a drastic upswing in the birth-rate or an equally surprising fall in the death-rate, we can expect to see a declining population

in the near future, and those countries will tend to count less and less among the forces of civilization because of their non-expanding numbers. They are dropping behind through sheer lack of 'punching power.' But whilst these countries have populations which are almost stationary, others are increasing rapidly in population, notably the following:

	Population 1933 in thousands	*Excess of Births over Deaths per 1000 population per annum*	
		1921–30	1931–35
Palestine . . .	1,380	22·0	23·7
Guatemala . . .	2,234	23·1	19·6
Salvador . . .	1,550	21·4	18·0
Mexico . . .	17,320	8·8	17·7
Philippines . . .	13,000	15·6	17·3
Ceylon . . .	5,430	13·4	15·9
Egypt . . .	15,146	17·9	15·7
Argentine . . .	12,026	17·5	15·2
Colombia . . .	8,830	14·4	15·2
Yugoslavia . . .	14,300	14·2	14·0
Bulgaria . . .	6,000	16·7	13·8
Japan	67,239	13·5	13·7
U.S.S.R. . . .	168,000	21·0 *	No figures

* 1923–25

Particular attention must be directed to Japan and Russia, whose existing population and rates of increase are bound to make them yet more formidable as national units. The Japanese growth from 33,000,000 in 1872 to 67,239,000 in 1933 was accompanied by the development and indeed by the adoption of those climatic controls which had done so much for north-west Europe and North America. Up to 1890 the paper-walled house was universal. The *Encyclopædia Britannica* of 1911 (vol. 15, p. 166) states, as an example of the quality of endurance possessed by the Japanese, that

> The average Japanese may be said to live without artificial heat; his paper doors admit the light but do not exclude the cold. His brazier barely suffices to warm his hands and his face. Equally is he a stranger to methods of artificial cooling. He takes the frost that winter inflicts and the fever that summer brings as unavoidable visitors.

Even as recently as in 1935 a keen Japanese observer could write:

> Most Japanese houses are not built of stone or brick like those in western countries. The principal building material is wood and bamboo. This is not due to the frequent occurrences of earthquakes, as many suppose, but to the peculiar climatic condition of this country.

Much of the wall space of our houses is given up to 'shoji' or sliding paper doors that can be removed to let the air pass freely into the rooms to the enjoyment of the occupant. During the night wooden sliding doors are shut outside the 'shoji.' Usually the farm-houses are thatched with straw and are cool in summer and warm in winter. The straw-thatched roofs are fairly durable, and have to be renewed once in about thirty years. In every farm-house there is a fire-place, or hearth, called 'irori,' in which fire-wood is burnt for warmth, cooking and heating. The smoke rising up from the hearth permeates the roof material and kills injurious insects in it. Nowadays straw-thatched roofs are being replaced by those covered with zinc-plated iron materials, which being very light require smaller columns of wood to support them and are less expensive.[1]

But all this is changing rapidly, more solid structures are being built, and the coal grate or central heating finds its place in the architectural plan. Coal-mining, which began only as late as 1890 when its technique had been learnt from the western nations, now supplies fuel in comparative abundance. And every decade now sees Japanese trade, prestige, and military power improving. The result has been astounding. The defeat of Russia in 1904–5 was not only the victory of a maritime people over a continental people, but also the victory of a people from a mild climate over a people from a severe one.

But in this brief glance at world history one fact must not be overlooked, viz. that whilst comparatively few people may build up a civilization, it takes numbers to safeguard it. For just as Rome conquered Greece, and Russia overran Finland, so in all struggles between nations brute force is a factor of no slight importance, and among nations enjoying almost equal conditions of climate and climate control, the leadership will go to that which has the greatest numbers. In boxing terms: 'A good big 'un will always beat a good little 'un, but a good little 'un will always beat a poor big 'un.'

Throughout history it might be said that civilizations develop where a people enjoy for the moment the best natural climate and have the greatest control over it, but if they are numerically weak, their growing art and wealth will incite raid upon raid until at last they succumb to outside pressure. If they are numerous and united, then indeed they may conquer the world, as nation after nation has proved, but if they are rent by internal dissension, whether due to religion, race, language, or dynastic reasons, then civilization will be checked; for so long as a people within a natural boundary are divided into separate political entities, so long will their maximum effort be retarded by rivalries and jealousies. The history of

[1] Takematsu Okada, *The Climate of Japan and its Influences on the Japanese People* (1915).

England and Scotland with its wasteful record of Border feuds and invasions; the history of Italy with its intrigues and treacheries; the history of Scandinavia or Ireland with their consuming political dissensions, or of old Germany 'with its tangle of lilliputian and irrational princelings,' all bear out the retarding effect of disunion.

And yet the forces of language, religion, or race are so strong that few, if any, natural areas of the world have been united even during the course of the last two centuries. Belgium and the Netherlands, Spain and Portugal, Norway and Sweden, and a dozen other areas bear this out.

In view of the importance of numbers to any nation, we must consider, not only present figures, but also the future trends of population. It is, perhaps, obvious that a country whose population is growing persistently decade after decade, whether through natural increase (i.e. excess of births over deaths) or from immigration, will tend to count more and more as a factor of importance in the world. Fortunately, in this respect we have perhaps the most accurate statistics possible for the greater part of the world, though there are striking gaps, as in respect of China and parts of Africa, where our information is of the scantiest kind. The League of Nations used annually to publish accurate statistics of population, including births and deaths for most countries of the world, and tables showing the natural increase.

It appears from the figures given a few pages earlier that the Asiatic countries, Egypt, and the Central American States are expanding yearly at the rate of about 18 per 1000, while the north-west European races only at a rate of about 5 per 1000. No figures are available for China or for the negro races; even in South Africa no registration figures of natives are available in one province, but the increase of non-European races there during the decade 1911–21 was assessed at 15·16 per cent. per annum. Assuming, therefore, that China is breeding less rapidly than Japan and more rapidly than India, and that the negro races are increasing at a rate somewhere between that of Egypt and that of the coloured races of South Africa, the conclusion is reached that *at the average existing rates* (1931–35) the population of the world will increase by some 250,000,000 during the next ten years, of whom 150,000,000 will be Asiatics.[1]

[1] Professor Charles Richet, President of the French Academy of Sciences, has estimated this increase to be 195,000,000 for the whole world and 140,000,000 for Asia. 'The Americas will grow by 35,000,000 and Europe by 20,000,000, others by little or nothing.' It is obvious that Africa will not remain stationary, and the estimate for Europe, including Russia, seems on the low side.

From the vital statistics of various countries we can get a good idea of the intense pressure of population in certain areas. The people of these countries, faced with the problem of securing elementary conditions of life for their increasing millions, can do this:

(1) by bringing more of their existing land under cultivation, or starting successful new industries;
(2) by increasing the fertility of lands now cultivated, or improving industrial technique;
(3) by spreading into other lands.

Nature, in fact, says to these nations, improve, expand, or accept a lower standard of living. England, Ireland, Germany, Russia, and Poland were all faced by these problems during the last century, and their expansion (emigration) to America and other areas was the main solution. Japan is faced with it to-day, for the Japanese villages present the most densely populated countryside in the world. Every small patch of arable land is already used for rice, barley, wheat, or mulberry. The production of rice for many years increased at a quicker rate than the growth of population, but the limit has apparently now been reached, while forestry and fishing are static industries. The prospect for the next decade is, therefore, a serious one, which emigration to the mainland may ease slightly. Other lands have closed the door against Japanese immigration, and it is doubtful if more than 50,000 emigrants can be sent out in any year, either to South America or to China.

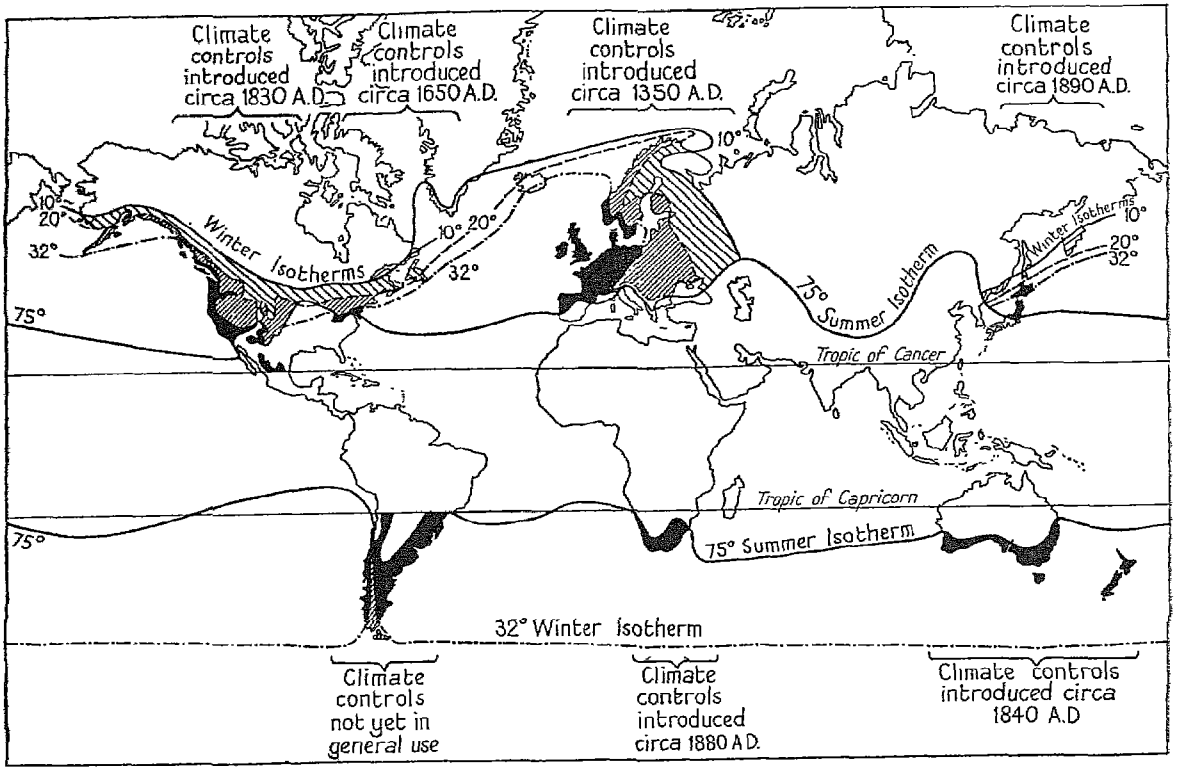
Agriculture, therefore, has reached its limits, expansion in terms of emigration is practically impossible: there remains industry. The expansion of industrial exports may provide her increasing millions with gainful occupations. At present between seven and eight millions are now employed in connection with Japan's foreign and colonial trade; if they can succeed in enlarging this trade, the greater part of the future increase in population can be absorbed. But international trade has been constricted by tariffs, quotas, and a hundred other products of economic nationalism. Japan has recently increased her share of the world's trade—but other countries in turn want foreign trade and resent the Japanese invasion of their markets—hence higher tariffs, greater restrictions. Is it the law of the jungle written in economic and diplomatic terms?

Mankind has shown amazing heroism in ensuring the continuance of the race—the Maori trek across the Pacific, the Parsee emigration from Persia to India, the European emigration of the

nineteenth century, all have been caused by pressure, intense pressure, at the heart of a nation. Expand, be energetic—or die! And nature's challenge is none the less a challenge because it comes in terms of trade treaties, industrial invention, or even the persistent thistle and other agricultural pests.

But history does not permit us to accept expanding numbers as the cause of civilization, for if so, countries such as India, China, and Russia would be in the van. Moreover, countries such as Greece 2000 years ago and Great Britain 300 years ago had a relatively minute population when compared with their rivals.

Sheer pressure of numbers, therefore, may make a nation warlike and cunning, but something more is needed to make them civilized. The Goths and Visigoths overran Europe, but they left it less civilized than before their advent. The Turk, too, could expand and conquer, but left in his train the proverb, 'Grass will never grow where the Turk's horse has trod.' Numbers alone may give a nation military power, but they will not give it a great civilization.



MAP TO SHOW THOSE AREAS OF THE WORLD WHERE TEMPERATURES FOR THE WARMEST MONTH DO NOT EXCEED A MEAN OF 75° F. AND FOR THE COLDEST MONTH DO NOT FALL BELOW A MEAN OF 32°, 20°, OR 10° F. (See pp. 87 and 88.)

VI

CLIMATES AND CLIMATIC CONTROL TO-DAY

PART I

IT has already been pointed out that only in maritime areas can a climate be found where the extremes between summer and winter temperatures are least marked. An island such as Hawaii may, therefore, be expected to show the minimum deviation from the mean. For Honolulu the temperature records go back 50 years and the difference between the mean temperature of the coldest January known (1905) and the warmest August (1900) is merely one of 12·6° F., from 67·2° to 79·8° F. But a monthly mean of 75° F. or over implies that nearly every day will produce several hours with a temperature well over 80° F. or even 85° F. Thus it may be said that wherever the temperature for any place for the hottest month passes the mean of 68° there will be many hours in that month when people will be subjected to climatic conditions too hot to be comfortable. At Greenwich, for example, where the mean temperature for the hottest month, August, is 62·6° F., several days occur nearly every year when the thermometer passes the 80° mark for perhaps an hour or two. There are, on the average, three days every year when the temperature rises above 85° F., and on eight occasions during the last 35 years temperatures of 90° or over have been registered both at Greenwich and at Kew for a short while.

Thus, London's 'heat handicap' amounts to at least three days per year, and on these days the temperature *for several hours* is over 76° and may rise higher than 85° for an hour or more.

If this then is the handicap of England, with her cool maritime climate, it follows that warmer countries, such as France, Italy, Greece, Mexico, &c., will have a much higher handicap, and so far no method has been devised for the cheap effective control of hot weather such as has been devised for cold weather.

The lowest temperature ever recorded in the British Isles was 23° F. below zero at Blackadder, Berwickshire, on 4 December 1879, and the highest temperature was 100·5° F. at Tonbridge, Kent, on 22 July 1868. But extremes of temperature which form the subject of newspaper headlines rarely persist for more than a few hours at most, and what we have to consider is not the

exceptional weather of any town or country, but the average weather that has to be endured for at least a month at a time, since shorter periods, although affecting human efficiency, if outside the ideal range, will not have any pronounced deleterious effect if followed by better conditions. Thus the monthly mean of temperature is the best criterion for our purpose.

In assessing the climatic conditions under which nations are working I have adopted the following method. First, the centres of population are determined and their mean annual temperatures and monthly means established over the longest possible period. To give a concrete instance, in assessing the climate of Australia as a factor in human energy, it would be absurd to take one record from the extreme north, and others from the extreme east, south, and west and calculate their average, since the bulk of the population is concentrated on the south-eastern seaboard. I have, therefore, taken the six largest cities (with suburbs) as follows: [1]

Town	*Population* 1931	*Mean Annual Temp.* °F.	*Mean Temperature* °F.		*Relative Humidity per cent.*	
			Coldest Month	*Warmest Month*	*Coldest Month*	*Warmest Month*
Sydney .	1,240,000	63·2	52·7	71·7	76	68
Melbourne .	1,020,000	58·5	48·6	67·5	82	60
Adelaide .	324,400	63·0	51·7	74·1	77	43
Brisbane .	317,000	68·9	58·5	77·2	75	68
Perth . .	210,000	64·2	55·2	74·1	73	66
Hobart. .	60,000	54·4	45·7	62·3	84	64

Now since Sydney has twenty times the population of Hobart it is evident that the climate of Sydney and its immediate neighbourhood affects twenty times as many Australians as does the climate of Hobart and its immediate neighbourhood, so that we must weight the Sydney figures in proportion. Similarly, Melbourne must be given seventeen times the value of Hobart: Adelaide and Brisbane a little over five times, and Perth three and a half times. We thus arrive at the following idea of the 'average' climate under which the majority of Australians live:

[1] Temperature and humidity figures in this and following tables are from *World Weather Records* of the Smithsonian Institution; Koppen, *Grundriss der Klimatkunde*; *Réseau Mondial*; and information supplied by the British Air Ministry (Meteorological Office). Where these sources differ, an average has been taken, giving equal value to each source.

Mean Annual Temperature °F.	*Mean Temperature of*		*Relative Humidity per cent.*	
	Coldest Month	*Warmest Month*	*Coldest Month*	*Warmest Month*
61·8	52	71	78	62

For every country in the world I have worked out similar tables, with this modification, that the more populous the country the larger number of centres that must be considered; thus for India, I have taken into consideration meteorological statistics covering the 24 largest cities, and for the U.S.A., the 20 largest cities, while for New Zealand the records for the 4 largest cities only have been considered.

By this means we get, if not the most exact idea of the climatic conditions endured or enjoyed by the inhabitants of every country, at least an effective approximation; where there are two or more distinct climatic zones in a given country (as for example the U.S.A., China, and South Africa) specific reference will be made to them.

With this method we arrive at the 'Table of National Climatic Conditions,' arranged in order of temperature from the coldest to the warmest countries, which is given as an Appendix.

For vast countries such as Russia it is difficult to indicate average climatic conditions. The figure given is, however, within 2° of that of Moscow and that of Leningrad, which have a larger combined population than the next 20 largest towns.

For Canada the great annual temperature range at Winnipeg of 71° F. from the mean of the coldest month to the mean of the warmest month is offset by the comparatively narrow range of Vancouver, and the figure given approaches to within 2° of the mean annual temperature of both Montreal and Toronto.

Thus the maximum margin of error in any country is not more than 2°, save in certain backward countries where meteorological information is very scanty.

The word 'tropical' has been appended to every country where the capital town or largest city is in the tropics. Shade temperature readings do not give a fair indication of the day warmth of these countries owing to the high radiation factor. To a lesser degree shade temperatures for countries such as Australia, South Africa, Greece, Mexico, and the southern U.S.A., all within 40° of the Equator, do not accurately convey the impression of warmth felt in day-time under a blazing sun. Altitude emphasizes this radiation factor and F. F. Roget has pointed out [1] that at high

[1] *Altitude and Health.*

altitudes in Switzerland the thermometer may range from well below zero at midnight to 120° when exposed to the rays of the midday sun.

Thus in attempting to estimate climatic conditions in various countries the way is full of pitfalls. It can only be repeated that the ideal climate is one where men neither shiver nor perspire when at rest.

It will be remembered that in Chapter III it was postulated that the ideal outdoor climate was one that ranged between 60° and 76° with a relative humidity of between 40 per cent. and 70 per cent., moderate air movement and adequate sunshine, and it was there suggested that these limits were rather wide. Yet there is not a single country in the world that enjoys these conditions for more than a few months at a time, although in certain small areas they prevail nearly all the year round. California for example (i.e. the area between San Francisco and Los Angeles) has almost an ideal climate throughout the year, and so has North Island, New Zealand, though in both areas humidity is a little higher than the absolute ideal, and there are a few days every year when the thermometer may rise above 85° and conversely a few days when it may drop to below freezing point.

From the tables given in the Appendix it would appear that the following countries have an almost ideal summer and an easily controlled spring, autumn, and winter:

Argentine (central area)
Austria (western area only)
Australia (southern portion)
Belgium and Luxemburg
Canada (southern British Columbia, southern Ontario and Maritime Provinces)
Chile (central area only)
Czechoslovakia (western area only)
Denmark
France (northern area)
Germany
Ireland
Netherlands
New Zealand
Norway (southern and western areas)
Poland (western portion only)
South Africa (south-eastern area)
Sweden (southern portion)
Switzerland
United Kingdom
Uruguay (southern portion)
U.S.A. (western seaboard, New England, and an area near Great Lakes)

In none of these does the mean temperature of the warmest month exceed 68° F. or that of the coldest month fall below 20° F., radiation is not excessive, and humidity declines in summer. To these might be added northern Portugal, northern Spain, north-western Italy, and parts of Greece, which, whilst having one or more hot months, have almost ideal conditions in spring, autumn,

and winter. In Finland and the Baltic States the winter is somewhat severer, but the climate otherwise is good. Japan, which otherwise is favoured, has not only high summer temperatures but also high summer humidity, nevertheless it has, with the east coast of China and the Mediterranean coast strip, the best climate in Asia.

We should, therefore, expect to find civilization at its highest in the countries in this list provided other conditions are equal, for these are the countries where men and women may work and play practically all the year round. But no country has an ideal climate, and if use is not made of houses, clothes, heating appliances, and so forth, the variations from season to season, or from hour to hour, may sap energy and health.

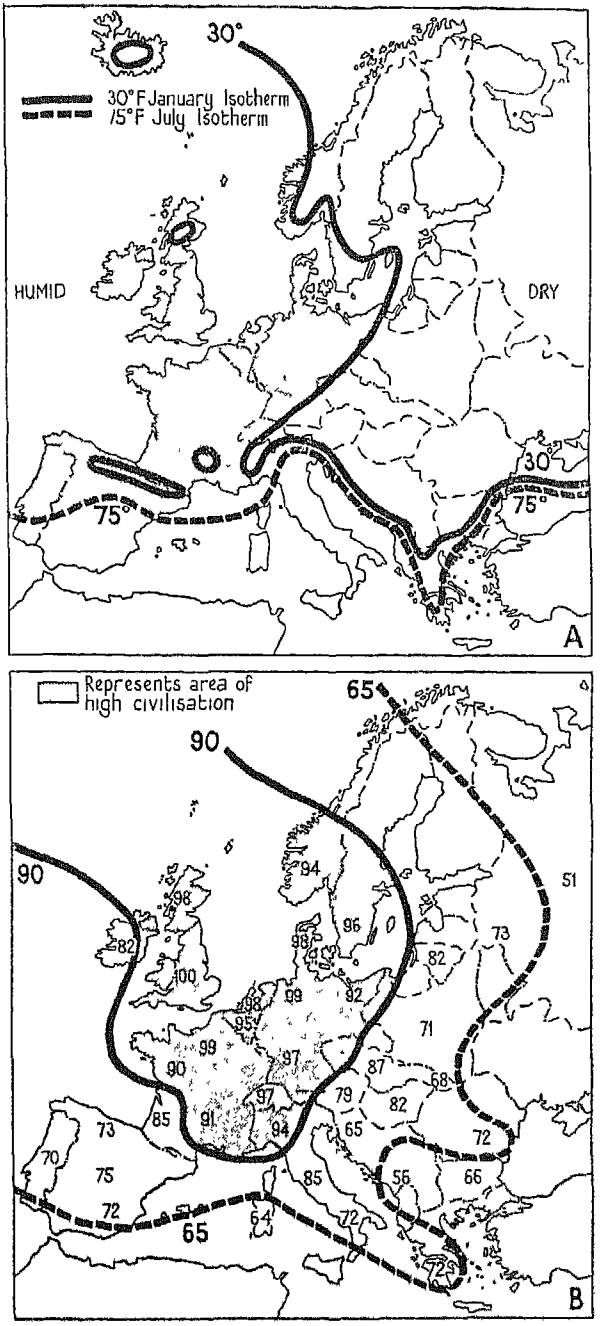
climate and an easily controlled spring, autumn, and winter, as well as adequate sources of artificial heat, coincides with the actual centres of civilization to-day.

Is it a coincidence that these countries are looked upon as being the most energetic? Perhaps the omissions are as startling as the list, for many would doubtless feel that Japan and Italy should be included in this last category, but we shall see from the following chapters that, judged by diverse tests, they do not reach the same high standard as the countries in the above list.

My list of ideal countries (i e. countries with an easily controlled climate all the year round) is based not only upon the consideration of statistics, but also upon personal experience of climatic conditions in almost every country of the world. Since this work was projected I have visited each of the five continents, and each succeeding journey has added new information, confirming the theory that man's energy depends basically on the climate in which he lives, that energy is a prime essential of any civilization, and that civilization follows climate control.

In short, the regions with an ideal climate (i.e. a climate that can easily be controlled all the year round so as to produce ideal indoor conditions and that permits outdoor exercise on most days), possessing at the same time cheap and effective means of climate control, are New Zealand, north-west Europe, and various portions of North America, South America, and Australia. New Zealand has a decided superiority over every other country in having an easily controlled climate and adequate sources of artificial heat available at moderate cost.

Let us subject now the nations of to-day to divers tests, in order to determine whether energy does in fact coincide with good climatic conditions.



EUROPE. (A) CLIMATE; (B) CIVILIZATION (after Huntington). See p 96

VIII

TESTS OF NATIONAL ENERGY

THE DEATH-RATE AND INFANTILE MORTALITY

By what methods are we to test national energy? It is no doubt easy to say that Greece was great and energetic at the time of Pericles, and that Rome was great and energetic under Julius Cæsar, but are there any incontrovertible standards of assessing national energy?

Mere accession or retention of territory may be disregarded at once: no nation can be accounted greater or more energetic because it rules over more acres than its neighbour, for were this so Mexico would be ranked higher than Sweden, and Brazil than Japan. Possibly a test that might be taken is that of the acquisition of territory by given countries over, say, several decades. It is a human characteristic to desire to extend one's area of power.

The two great colonizing powers of the world, Great Britain and France, have each a colonial history dating back hundreds of years. These two powers alone have dominions occupying 18,000,000 square miles, and containing 500,000,000 inhabitants. The full extent of overseas possessions of these and other powers was in 1936 as follows: [1]

	Home Area (*sq. miles*)	*Area of Dominions or Colonies* (*sq. miles*)	*Home Population* 1936	*Population of Dominions or Colonies*
Great Britain	95,030	13,900,000	46,600,000	454,000,000
France . .	213,000	4,600,000	41,900,000	65,700,000
Netherlands .	13,214	812,260	8,300,000	62,800,000
Japan . .	260,800	116,500	66,500,000	28,500,000
United States	3,027,000	712,000	125,200,000	14,300,000
Belgium .	11,750	960,000	8,250,000	13,500,000
Italy . .	120,000	1,200,000	48,000,000	12,500,000

In another direction the United States expanded from their original area of 819,466 square miles in 1776 to 2,974,159 square miles in 1890, and with the 'closing of the frontier' in the latter year came the beginnings of an overseas Empire, and 125,000 square miles were added in three years, 1898–1900.

[1] Figures from *League of Nations' Year Book*, 1935–36, pp. 18–23, and *Whitaker's Almanack*, 1939.

These extensions of territory indicate a considerable virility on the part of the nations concerned, just as Spain's great losses in the nineteenth century marked a corresponding lack of vigour. But it is by no means a safe test of national energy, for Germany's great territorial losses in 1918 were due not to any lack of energy in the individual or mass, but to the fact that after a four years' war the massed forces of 600,000,000 people had beaten the forces of 100,000,000. It is true that had German diplomacy been better, some nations, such as Italy or Roumania, might have been enticed into the war on her side, the U.S.A. might have been kept neutral, and the result might have been favourable to Germany, with an eventual corresponding increase of territory for herself and her allies. But would this have proved, for example, that Austria-Hungary was more energetic than Belgium? Belgium certainly fought heroically, and the United States fought with equal determination in the last eighteen months of the war, but does the subsequent increase of Belgian territory by 35,000 square miles and of the U.S.A. territory by 132 square miles (through the purchase of the Danish West Indies for $25,000,000 in 1917) give us a measure of the comparative national energy of the two peoples during that particular period?

Similarly, is the acquisition of 48,506 square miles by the U.S.A. from France in 1804 for £3,000,000 to be compared with the reclamation of the Zuyder Zee by the Dutch during the period 1918–33—530,000 acres at a cost of £100,000,000? Again, the history of Denmark during the last 80 years shows how territory may be lost and re-acquired without credit or discredit to a nation's vigour.

It is evident, therefore, that whilst the acquisition of territory may give an indication of national energy, it cannot, and does not, afford anything like an accurate basis for comparison.

Similarly, the winning of wars, or naval or military strength, must be disregarded. A strong coalition may defeat the most energetic nation in the world. A country like Turkey, or Greece, may in the short space of a dozen years win or lose two or three wars. Naval, military, or air strengths are equally fallacious. Is Switzerland to be placed in the lowest rank of nations because its armaments are relatively small? These are only the more obvious objections to assessing a nation's energy by its display of armed force.

Various other methods give rise to other objections, but a distinguished American, Dr. Frederick Osborn of the American Museum of Natural History, devised for the United States an 'index of cultural intellectual development' in the various States,

based upon mental tests among school children, army intelligence tests, illiteracy percentages, magazine readers per 100 of the total population, and other criteria.[1] This index shows Washington, California, Massachusetts, Oregon, and Connecticut heading the list, while all the States of the south-east (except Florida), from New Mexico to Virginia, come at the foot of the list. A glance at the climatic records of the U.S.A. shows that the Pacific States have possibly the best climate of any, followed by Massachusetts and Connecticut, while Louisiana and Mississippi, which are at the foot of Dr. Osborn's list, are less favoured. Compare:

	Mean Annual Temperature (°*F.*)	*Temperature* (°*F.*)	
		Coldest Month	*Warmest Month*
Portland, Oregon . . .	52·5	39·0	66·6
San Francisco, California .	55·0	49·4	60·0
Los Angeles, California . .	60·0	53·0	68·5
Mobile, Alabama . . .	67·0	51·0	80·4
New Orleans, Louisiana .	68·0	54·0	82·0

Moreover the south-eastern States have a much higher humidity than the others.

Our inquiry would be rendered much easier if similar tests could be applied everywhere, but even the figures for illiteracy are difficult to obtain for the majority of countries. Unfortunately, we have no general intelligence test which we can apply to the nations of the world. Some such test has long been sought for, and interesting criteria, such as the production of 'great' men, illiteracy, inventive ability, and so forth, have been considered, but for none of these have we world-wide statistics that can be regarded as non-controversial. Prof. Ellsworth Huntington produced a fascinating study of civilization based on personal estimates that is illustrated on p. 93; but it is very difficult to make correct allowances for personal preferences.

What then are the tests that we can apply? Human nature, it is said, is the same the world over, and certainly the desire to prolong one's own life, to be free from illness, to make money, and to be of good repute among one's fellows, is to be found everywhere, and human energy can in some sort be judged by the extent to which various nations attain these aims.

But how can their success be assessed statistically? The death-rates and infantile mortality rates help us with the first of the above aims; and success in money-making can be calculated from national incomes and world trade. I should have liked to

[1] Paper read before the Eugenics Society of America, May 1933.

take some other measure, such as inventions, but world figures here are misleading, since patent laws vary in various countries.[1]

Let us, therefore, first take the death-rates and infantile mortality rates; these reflect preventive medicine and human energy as much as the natural healthiness or unhealthiness of an area, for how otherwise are we to explain the striking decline in the death-rates in nearly all countries over the last twenty years? It is not that diseases have grown less terrible or potent, but that man's energy has extended his conquests over them. Death-rates and infantile mortality rates for the principal countries are as follows:

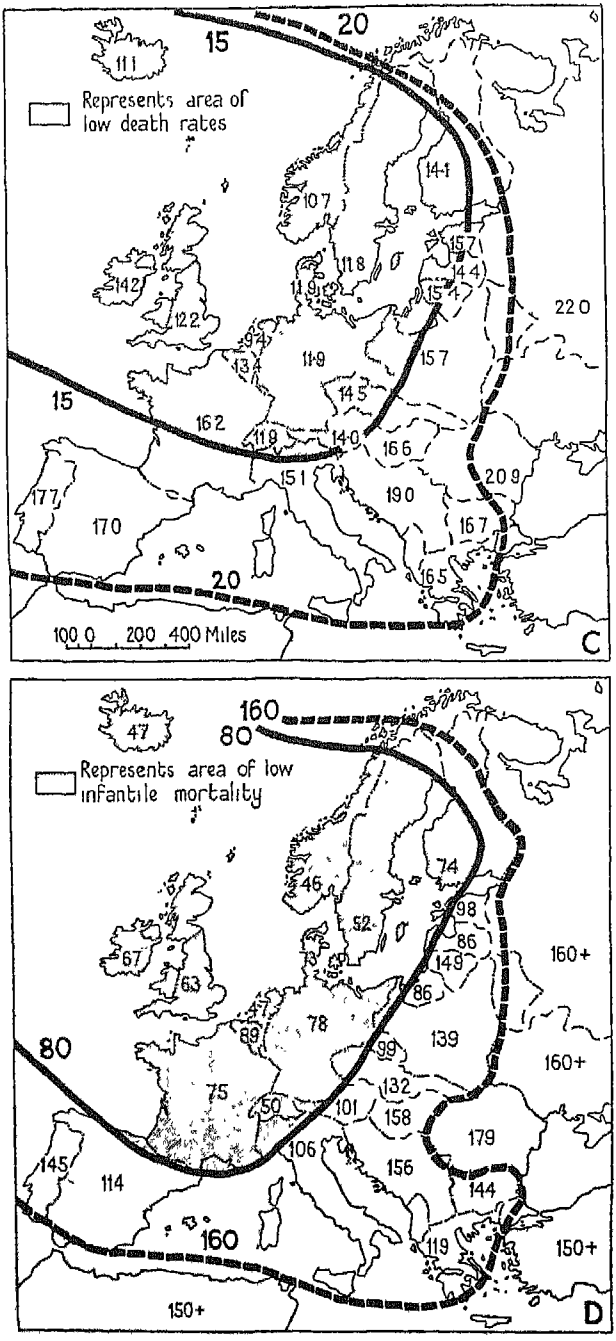
DEATH-RATES, 1926–35, PER 1000 INHABITANTS AND INFANTILE MORTALITY RATES, 1926–35, PER 1000 LIVE BIRTHS

	Death-Rate	*Infantile Mortality*		*Death-Rate*	*Infantile Mortality*
New Zealand	8·4	40	Greece	16·5	121 †
Australia	9·1	46	Japan	18·6	128
Norway	10·6	47	Czechoslovakia	14·5	138
Netherlands	9·4	50	Salvador	23·3	140
Switzerland	11·9	51	Poland	15·7	142
Sweden	11·9	54	Portugal	17·7	146
U.S.A.	11·3	63	Bulgaria	16·6	147
United Kingdom	12·2	67	Venezuela	18·2	149 †
Irish Free State	14·1	69	Lithuania	15·4	150
Denmark	11·0	76	Yugoslavia	19·1	152
Finland	14·1	80	Philippines	18·9	154
France	16·2	81	Mexico	25·0	154
Canada	10·4	84	Egypt	27·0	158
Germany	11·4	84	Palestine	22·4	164
Belgium and Luxemburg	13·3	89	Hungary	16·4	164
			Ceylon	23·3	168
Latvia	14·4	90	India (British)	23·7	174
Uruguay	10·5	99	Roumania	20·9	187
South Africa	11·5	100 *	Burma	18·0	201
Esthonia	15·7	100	Chile	25·2	238
Argentine	12·7	103	Russia	21·0	190 †
Austria	13·9	108	China	No figures	
Italy	15·0	112	Brazil	,,	,,
Spain	17·0	118			

* The figures for the white population are 9·8 and 65, those for the native population are about twice these, but in view of lack of reliable figures those given above must be regarded with caution. See *Official Handbook of the Union* (1930–31), pp. 831 and 1020.

† Incomplete figures.

[1] Up to 1934 the patents issued number approximately as follows: U.S.A. 2,000,000, France 900,000, Great Britain 800,000, Germany 600,000, Canada 326,000, Italy 280,000, Japan 84,000, U.S.S.R. 64,000, which gives the palm for invention *per capita* to the relatively small population of Canada. Patent laws, however, vary so much in different countries that the basis of comparison is not to be relied on.



EUROPE: (C) DEATH RATES; (D) INFANTILE MORTALITY, 1930–4
(Cp. meteorological map on p. 93)

It may be asked why infantile mortality, which is part of the death-rate, is shown separately and why importance is attached to its distinct rendering. The answer is that the death-rate by itself may give erroneous conclusions. For example, deaths from violence (probably five per cent. of the total number in most civilized nations) and deaths indirectly due to war privations or injuries swell the figures. Emigration too may affect the figures. But greater than these influences is that of maturity. If a country has a very low birth-rate, it follows that the average age of the population will become progressively higher, and in countries such as France, Austria, Esthonia, and Sweden the height of the death-rate is due in part to an ageing population.

Possibly the infantile mortality rates give a better indication of national health and energy, since neither emigration nor deaths by violence greatly affect these figures, though in parts of Africa and Asia infanticide is still practised. There are, however, few who do not regard the saving of a child's life as a creditable action, and throughout the world the care and successful upbringing of infants are looked upon as meritorious.

A glance at the figures given above brings out some striking facts. New Zealand, Australia, the Netherlands, and Norway occupy an enviable position on both counts, but as one runs down the table curious discrepancies are observed. The Irish Free State (Eire) and France have relatively high death-rates compared with their infantile mortality rates, while Canada, Uruguay, and the Argentine seem to have relatively high infantile mortality rates. But in general the figures of either column do give us an idea of the healthiness of a given country; they also reflect in no uncertain manner man's effort to overcome disease and suffering. In every case, save perhaps one or two countries at the foot of the table, the figures show a striking improvement when compared with those of half a century ago, and in most countries the infantile mortality rates have declined by half. In the United Kingdom, for example, the infantile mortality rate has declined from 143 per 1000 (1881–90) to 53 per 1000 (1938). Similarly, in New Zealand over the same period the rate has declined from 87 per 1000 to 39 per 1000.

I spent recently a few months in New Zealand and made many inquiries into its inspiring record of infant welfare services. The people themselves [1] attribute their low infant mortality to climate, race virility (both similar to our own and to those of north-

[1] *New Zealand Official Year Book* (1933), p. 109.

west European countries), and *partly to legislative and educative measures, the latter adopted both by the State and by various organizations.*

It need hardly be said that it requires more energy and thought to improve the position of the leader in the great crusade against disease and accident than to follow in the paths that others have cleared.

I think it will be agreed that these tables therefore do give us an indication of energy, since energy is broadly dependent upon health. But before we advance to a consideration of other tests of energy it may be well to consider the climate and climatic controls of the best and worst countries.

All observers will agree that in New Zealand, Australia, the Netherlands, Norway, &c., the standard of life is such that all can afford well-built houses and the requisite fuels to ensure the warming of them. Further, I think it will be agreed that each of these countries and the other countries at the head of the list have climates which can thus be controlled for the greater part of the year. And as one goes down the table one is struck by the gradual worsening of the climates until the steamy heat of Burma or the Arctic cold of Russia is met.

But there is one striking exception—Chile. It is true that Chile extends from the tropics to the frozen south, but the greater part of her population of 5,000,000 is concentrated in the centre, i.e. between Antofagasta, 23° S., and Concepción, 38° S. This area is climatically comparable with south-east Australia and North Island, New Zealand. All three countries are isolated from foreign-born epidemics, Australia and New Zealand entirely by sea, and Chile by the sea and the Andes. Chile has a population of 5,000,000, mainly of European origin, with indigenous Fuegians (nomadic, in the extreme south), Araucanians (102,000 in the valleys or on the western slopes of the Andes), and the Changos of the northern coast region. The Australians and New Zealanders are also of European stock (mainly British), but there are a few Asiatics, and some 90,000 Maoris in New Zealand.

In Chile the total area of agricultural land (1927) was 59,038,055 acres; in New Zealand the total area of agricultural land (1931) in occupation was 42,239,585 acres.

If we compare the Chilean cities of Santiago and Valparaiso, which contain a quarter of the total population of the country, with the principal Australian and New Zealand cities, which contain over a fifth of their population, we find:

	Population in thousands	*Mean Annual Temp. °F.*	*Temperature °F.*		*Relative Humidity per cent.*		*Lat. °S.*
			Coldest Month	*Warmest Month*	*Coldest Month*	*Warmest Month*	
Santiago	712	56·4	46·0	67·3	83	61	33
Valparaiso	200	57·0	43·0	63·0	75	66	33
Auckland	218	59·0	52·0	67·0	82	73	37
Wellington	140	55·3	48·0	62·5	78	72	41
Sydney	1240	63·2	52·7	71·7	76	68	34
Melbourne	1020	58·5	48·6	67·5	82	60	38

But Chile produces only 0·3 metric tons of coal and lignite per head, New Zealand three or four times that amount, and Australia five times; similarly, where Chile produces only 66 kw.h. of electricity per head, New Zealand produces 500 kw.h. and Australia 373.

Thus where south-east Australia and New Zealand have almost perfect climatic control indoors, Chile has very little, and the populated areas of all three countries require heating appliances for at least six months in the year to bring indoor conditions up to that point between 60° and 76° which is regarded as the local ideal.[1] The three regions are indeed comparable, yet Australia and New Zealand have the lowest mortality rates in the world, and Chile about the highest. Can it be, as the *Encyclopædia Britannica* suggests, that in Chile, 'although the climate is healthy and agreeable, the death-rate among the common people is abnormally high on account of personal habits and insanitary surroundings'? And is it possible that the known lack of energy in Chile may be due to lack of adequate methods of climate control?

Roumania likewise has neither coal nor electricity in abundance: she produces only 29 kw.h. per head per annum and practically no coal. It is only in the past decades that her oil wells have been developed, but few of the peasants as yet use oil as a fuel.

A healthy rate does not, therefore, depend entirely upon natural climate, nor upon absence of industrial undertakings, nor upon the density or sparseness of the population. It does not depend upon proximity to the sea, for Switzerland shows some of the best figures, nor upon race, for the United States and Canada prove that the negro can flourish in the temperate zones; likewise the Japanese appear to be more healthy in Hawaii than in their own

[1] See above, Chapter III.

country. But a good health rate does appear to depend upon man's control of his environment and disease, and as such is one of the surest tests of national energy.

Are these countries then with the lowest infantile mortality rates the most energetic because the children that survive there are healthier than those in countries with high infantile mortality rates? There is no doubt about the healthiness of the surviving children in the countries at the head of the table as compared with those at the foot, since the mortality rates for the survivors follow closely the infantile mortality rates.

IX

TESTS OF NATIONAL ENERGY: NATIONAL INCOMES, AND WORLD TRADE

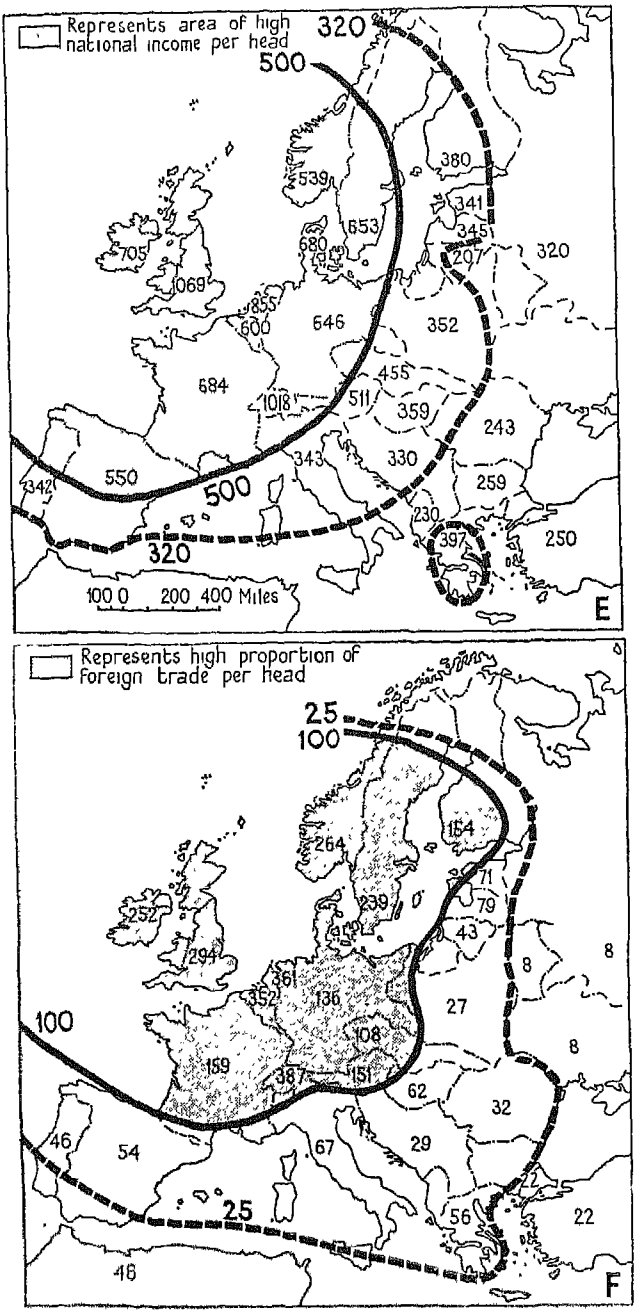
ONE of the surest indications of national energy is the effort to secure and retain wealth. The mere possession of money or property presents to the average individual a sure barrier, not only against poverty, but against discomfort in many other forms, such as ill-health in certain aspects, unhappiness due to a low social status, or the inability to follow congenial lines in work and recreation. The normal individual, therefore, will work and strive for money or a monetary equivalent, and whilst many will work for prestige or the sheer joy of achievement, the expectation of monetary recompense is no doubt one of the main incentives to human effort.

Yet the various nations show considerable differences in their capacity for money-making. The *per capita* wealth of various countries ranges from about £600 per head in the United States and the United Kingdom to a few shillings only in many equatorial countries; but the *per capita* wealth is a very poor test of national energy, since purchasing power, wage rates, &c., vary from area to area. National income is perhaps a better one.

A. NATIONAL INCOMES

For some time I hesitated about considering national wealth, national income, or private incomes as tests of national energy. It seemed to me that countries rich in natural resources and somewhat underpopulated, such as the United States, Canada, Australia, and the Argentine, would show much greater wealth *per capita* than other territories lacking great natural resources such as Belgium, Holland, and Norway, even though the energy of the latter might be as great as that of the former. But a detailed study of Colin Clark's *The Conditions of Economic Progress* (1940) has modified my opinions to the extent that, whilst I am still unwilling to accept national income as an unchallengeable estimate of national energy, I am willing to accept it as a broad comparative indication.

Clark has assessed economic welfare in terms of an 'international unit' which is defined as the amount of goods and services which could be purchased for $1 in the U.S.A. over the average of the decade 1925–34. As he himself says, 'The method . . . does not claim any metaphysical finality, and is indeed the measurement



EUROPE: (E) NATIONAL INCOME IN INTERNATIONAL UNITS; (F) WORLD TRADE, PROPORTION PER HEAD, 1926–35. (Cp. meteorological map on p. 93)

of only part of economic welfare, which in itself is only part of well-being as a whole.'

According to his summary,

the world is a wretchedly poor place. An average real income of below £2 or $10 per week per breadwinner is the lot of 81 per cent. of the world's population. A standard of living of over 1000 I.U. per worker per year (or over £4 per week) is found only in U.S.A., Canada, Australia, New Zealand, Argentine, Great Britain, and Switzerland. . . . About 53 per cent. of the world's population, including the whole populations of India and China, enjoy a real income per head of less than 200 I.U. (i.e. well under £1 per week).

It is interesting to note that real incomes have been rising in most countries during the past half century; in New Zealand, Australia, and Switzerland the upward trend has been very rapid, while in Great Britain progress, though it has not been so spectacular, has continued.

The chart (p. 106) is a simplification of Clark's chart of real income per head since 1900. Clark gives the following figures of real income per head of population in International Units [1]:

U.S.A. . 1381	Belgium . 600	Italy . . 343
Canada . 1337	Spain . . 550 *	Portugal . 342 *
New Zealand 1202	Chile . . 550 *	Estonia . 341
Great Britain 1069	Norway . 539	Yugoslavia . 330
Switzerland . 1018	Austria . 511	Egypt . . 325 *
Argentine . 1000 *	Czecho-	U.S.S.R. . 320
Australia . 980	slovakia 455	South Africa 276
Netherlands 855	Brazil . . 450 *	Bulgaria . 259
Eire . . 705	Greece . 397	Turkey . 250 *
France . 684	Finland . 380	Roumania . 243
Denmark . 680	Hungary . 359	Albania . 230 *
Sweden . 653	Japan . . 353	Lithuania . 207
Uruguay . 650 *	Poland . 352	British India 200
Germany . 646	Latvia . 345	China . . 110

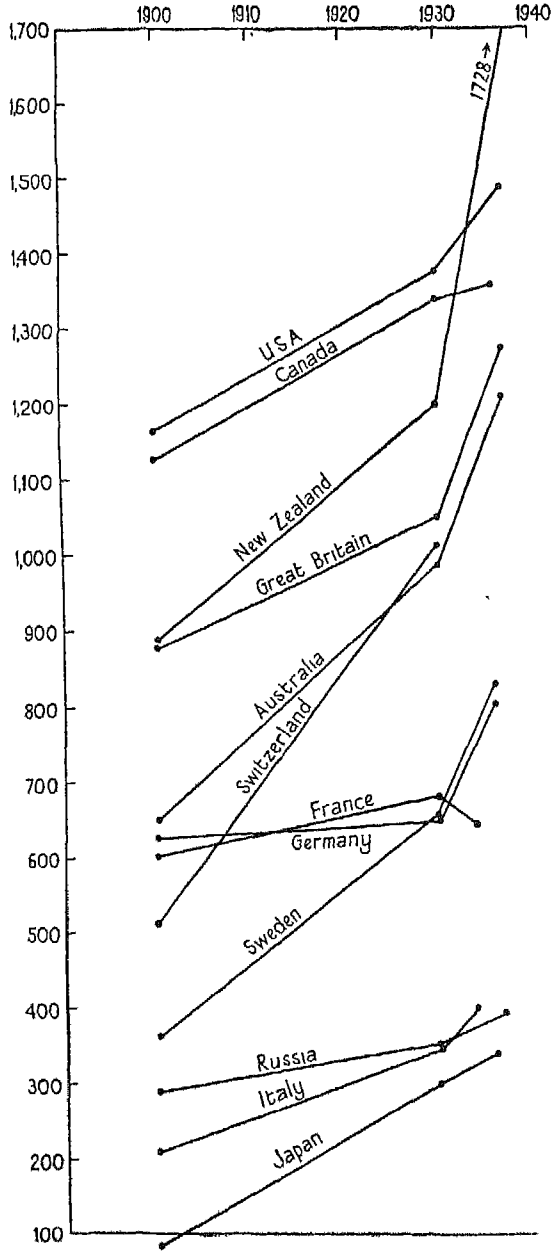
* Approximate figures only.

It is interesting to note that the leaders in this table are, broadly speaking, those in the previous table given relative to vital statistics, but there are certain changes in order, as perhaps might have been expected. South Africa and Norway take much lower places, whilst the Argentine and Chile are surprisingly high, but Clark admits that these last two are only approximate figures.

B. WORLD TRADE AS A TEST

But before I begin to compare tables let us first consider another test of national energy, that of the share a given country can obtain

[1] Clark, op. cit., pp. 40 et seq.



NATIONAL INCOMES PER HEAD SHOWING THE COMPARATIVE ADVANCE IN CERTAIN COUNTRIES, 1900–40. (See p. 105)

of the world's trade. It is only to be expected that each area of the world will produce the bulk of its own material requirements within its own borders: where a nation does not do this—as, for example, during a great famine, or an exhausting war—a reduction of the general standard of living will ensue. But every nation in some field produces a surplus to its own requirements, whether of grain or of motor-cars, and if that surplus can be sold or bartered over the borders, the nation gains accordingly. At this point, however, it has to face the competition, the skilful, merciless competition, of the rest of the world: for whilst any country may restrict its own interior market to its own products, and make itself by various means the most favoured seller in its own area, the moment its goods cross the border they enter markets less favourable to them, markets where sales can be effected only by superior value, which in turn implies the production of commodities of a given quality at a lower selling price than that at which they are offered by its most favoured competitor. Hence, external trade is an indication of the measure of a nation's energy. The ingenious, industrious, inventive nation will devise ways of extending its markets even in the most unlikely fields. The indolent, corrupt, inefficient nation will gradually lose its external markets or, indeed, never acquire them.

How are we to test this phase of national energy? Exports and imports in terms of dollars or pounds are useless as an indication—*for a survey of the export trade of the world during the years* 1929–33 would lead one to suppose that the whole world had lost much of its energy, since the value of world trade declined to a third during that period. Exports and imports in bulk are also fallacious, since a given bulk of cotton cannot be compared with the same bulk of a manufactured article such as clocks. But if we take the total volume of world trade and assess the percentage of it that a given country has secured over a period of years, we have a fair indication of the relative commercial energy of that nation, and neither tariffs nor any other form of commercial handicap will materially affect the conclusion. If a free trade country suddenly becomes stiffly protectionist, the total sum of world trade will be reduced by the limitation of imports into that country, and each of the countries formerly exporting to that market will have a more intense struggle for such other markets as still exist; the successful will show a rising percentage of the reduced volume of world trade, whilst the unsuccessful will drop down the scale.

It is, perhaps, beyond question that every country will endeavour to secure 'favourable' trade balances—i.e. to sell more than it buys

—and countries will go to great lengths to secure this, and tariffs are a recognized weapon in the struggle. The Hawley-Smoot tariff in the United States in 1930, for instance, raised American duties on imports of manufactured goods to unprecedented heights; but it was also the signal for an outburst of tariff-making in other countries—none of which, of course, publicly mentioned the word 'reprisals.' Extensive increases in duties were made almost immediately by Canada, Cuba, Mexico, France, Italy, and Spain, and a year later general tariff increases were announced by India, Peru, the Argentine, Brazil, China, Italy, and Lithuania—not to mention Great Britain's adoption of tariffs in 1931. The Hawley-Smoot tariffs certainly restricted imports into the U.S.A., but exports from the U.S.A. were in consequence much less welcomed than before.

Similarly, manipulation of the currency has been used to create a favourable balance. Controlled inflation, abandonment of the gold standard, and other devices have been adopted to secure the desired balance; but other countries follow suit, sometimes with a rapidity that bewilders their own producers as much as foreign importers. Before the outbreak of the War, the majority of countries of the world had abandoned the gold standard, and had adjusted their currencies in some way or other. Each country will use the tariff or currency control as best suits it to further its own trade. The national percentages of world trade thus reflect the skill or lack of skill of the various nations.

It is evidently necessary that for this comparison any statistics considered should be free from national bias, and I have, therefore, taken the figures given in the 'Statistical Year Books' of the League of Nations. Unfortunately these tables apply only to the period since the War of 1914–18, but they have been supplemented to give some indication of the state of trade prior to that war.

Now in 1913 the leading commercial country of the world was the United Kingdom, with 13 per cent. of the total trade of the world, the U.S.A. coming next with 11·17 per cent., closely followed by Germany and France. The rest were comparatively inactive. The war years not unnaturally reduced Germany's figure to a vanishing point, while the external trade of Great Britain and France also suffered considerably. By contrast, American and Canadian percentages rose from 11·17 (1913) to 15·15 (1926) and from 2·84 to 3·86 respectively.[1]

[1] The Information Section of the *Economist*, the Statistical Library of the London School of Economics, and other sources have not been able to help with the pre-war figures. I have, therefore, relied for the pre-war figures on statements given in *Hansard*, which are preceded by a word of caution as to their accuracy.

To put it in another way, in 1913 Europe (including the U.S.S.R.) held 58·4 per cent. of world trade, North America 14·1 per cent., and Asia 12·1 per cent. By 1926 the European figures had declined to 48·1 per cent., but North American and Asiatic trade had increased to 19·1 per cent. and 16·6 per cent. respectively; while South American and African trade remained stationary. Why should North America and Japan have captured European trade during these years, but not South America?

Again in the post-war years we note the swift dramatic decline of North American trade during the years 1926–34, not only in terms of dollars, but in terms of percentages of world trade. In the latter year North America took only 13 per cent. of world trade, Europe 54·8 per cent., and Asia 14·8 per cent. We also note the increasing percentage of the United Kingdom, France, Belgium, and the Netherlands over the same period. The conclusion is inevitable, that while during the war, and the immediate post-war years, North America was clever and energetic enough to secure a great portion of world trade, it was not able to retain that percentage against the reviving energy of Europe. Japan, however, retained her proportion and even increased it.

Let us consider what this trade struggle means in terms of one commercial product—the motor-car. During the period 1915–29 the U.S.A., by virtue of superiority in engineering skill and sales methods, captured the world's market, and by 1929 was producing 5,358,000 vehicles, of which 583,000 were exported.[1] In the same year the United Kingdom produced 239,000, of which 42,321 were exported.[2] By 1932 the U.S.A. production had dropped to 1,371,000 vehicles, whilst British production had increased to 247,000. In other words, in a declining world motor-car market, Great Britain's proportion of the whole market had risen from 3·6 per cent. to 12·4 per cent., and the U.S.A.'s proportion had declined from 81 per cent. to 69 per cent. in the same four years.[3]

In the years 1932–35, however, Great Britain, whilst doubling its production and exports, took a smaller percentage of the total world market. America improved its sales, not only in Continental markets such as Holland, but also in Britain itself, owing partly to the devalued dollar, and partly to the improved appearance and performance of the American product. Meanwhile Germany, a negligible competitor in 1932, multiplied her production and exports sevenfold.

[1] *United States Commerce Reports*, 25 May 1931.
[2] *Hansard* 235, col. 247.
[3] *League of Nations Statistical Year Book*, 1935–36, p. 167.

And so the struggle goes on—the struggle to produce the most popular article at a competitive price, the struggle to achieve the best conditions for that sale, whether by governmental action or mass suggestion. And the nation with the greatest number of ingenious specialists, of trained alert business men, of equally alert and competent politicians, will extend its share of world markets in every direction where there is anything like a competitive field, and often where there is not.

We might turn from motor-cars to agricultural produce, such as wheat or beef. Here again, whilst each producing country can conserve its own markets for itself, *if it wishes*, the moment it begins to produce an exportable surplus it comes into the region of fierce competition. A country such as Great Britain, by far the largest importer of meat in the world, can pick and choose, and will indeed only purchase from those countries which, in turn, are likely either to sell most cheaply or to render equally valuable concessions in other directions. Up to 1933 Great Britain had made little attempt to reserve even a portion of its market for the home producer, but in that year an imports restriction policy, designed to assist the home farmer, limited all exporting countries, whether Empire or foreign, to a given quota. At the same time the German duty on frozen meat, together with stringent veterinary regulation, virtually prevented the importation of frozen meat into Germany, while the quota system in France and the Netherlands, and heavy import duties in Italy, Belgium, and the United States, all restricted the post-war market.[1] Previously, at Ottawa, Britain had assented to measures which favoured Empire imports.

The result was the fiercest 'meat war' yet seen between such countries as the Argentine, Uruguay, and Brazil, for what remained of the world market. The United Kingdom imported over 600,000 tons of beef (mainly chilled) every year, and up to 1933 over 70 per cent. of this was received from the Argentine. Uruguay and Brazil were the only other suppliers of any importance of chilled beef, while Australia, the Argentine, and New Zealand were the chief sources of the supply of frozen meat.

In short, the Argentine was threatened with the loss of her greatest overseas market. Being energetic, she made every effort to retain it.

In February 1933 the Argentine sent a special mission to England to negotiate a commercial agreement, and on 1st May of that year a three-year Convention was signed under which the United

[1] *Cattle and Beef Survey*, 1934 (Stationery Office).

Kingdom undertook not to restrict imports of Argentine chilled beef into the United Kingdom below the quantities permitted under the Ottawa Agreement Act, and then only after consultation with the Argentine Government, and that there should be no restriction of Argentine imports of frozen beef below the Ottawa levels, unless Dominion imports were similarly reduced. The Argentine in return made certain financial concessions, reduced certain duties on British imports, and stabilized others. How much energy is required to conceive and negotiate an agreement of this kind?

These references to two specific trades prove very little, but when all the figures for all trades are added together *over a period of years* we must assume that the nation that gets a large portion of world trade has displayed considerable skill and energy. It will, of course, be granted that a currency change, a new tariff, or a new treaty may considerably improve the trade of a given country for a short period, but other nations can use the same weapon *and will do so* if national advantage can be secured thereby. It is the sustained volume that leads us to conclude that over a given period the quota of national energy is a high one.

Exports do not, however, tell the whole story, for countries such as Great Britain also sell shipping services and banking, insurance, and copyrights; Switzerland sells tourist facilities to foreign visitors, and many countries add something to their portion of world trade in this way. With the money thus gained from trade and services, imports from foreign countries are purchased, so that imports in a way give us a better idea of a nation's energy than exports; I have therefore taken both and combined them.

The result gives us a combined figure for the selling energy of a nation and its purchasing power.

Thus of all the means that we can take to assess national energy, trade figures should certainly be considered; we must however remember that, other things being equal, a country with a population of 50 millions will do more trade than one with a population of a million, and therefore it is essential to take figures per ten million population.

The League of Nations has given much thought to the problem of presenting accurate statistics in this field, and since 1929 has published annually in its *Statistical Year Book* comparable trade figures for all countries from 1926 onwards, including tables showing the percentage of world trade secured by each country. According to these figures the percentage of world trade secured

by the five leading countries of the world from 1928 to 1935 was as follows: [1]

	1928	*1929*	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*
U.S.A. .	13·65	13·83	12·24	11·24	10·92	9·89	9·53	10·79
U.K. . .	13·13	13·05	13·38	13·47	13·38	13·59	13·85	13·93
Germany .	9·17	9·35	9·61	9·78	9·29	8·90	8·67	8·55
France .	6·16	6·19	6·72	7·16	7·31	7·61	6·86	6·06
Japan . .	2·78	2·87	2·61	2·86	2·94	3·09	3·32	3·53

Now if we take the average of these annual figures for each country and divide the result by the tens of millions of population of each in 1931, we get the following proportions of the world trade per ten million population:

U.K. . .	2·94	Germany .	1·36	Japan . .	·47
France . .	1·59	U.S.A. . .	·99		

The Economist for 4 August 1934 gives us figures for 1913 and for 1929–33 that may be compared with these, for the *per capita* value of foreign trade was then:

	1913	*1929–33*	*1936*
U.K. . .	£25 18*s.*	£28 10*s.*	£26 4*s.*
France . .	£15 7*s.*	£16 9*s.*	£11 7*s.*
Germany . .	£15 4*s.*	£15 5*s.*	£10 8*s.*
U.S.A. . .	£ 9 0*s.*	£ 9 11*s.*	£ 7 6*s.*
Japan . .	£ 2 12*s.*	£ 4 5*s.*	£ 3 8*s.*

The small difference between the 1913 proportion and the 1929–33 proportion is astonishing—for in spite of a world war, a boom, and a depression, all of unparalleled magnitude, the trade proportions per head are only fractionally different from 20 years earlier. Japan alone shows a definite increase, and Japan, as we have said before, is rapidly adopting the climate controls of the west.

It may be argued that a small country will automatically export and import more goods per head than a large country because of the limited range of its natural resources, but a glance at the full table given as an Appendix shows that if like are compared with like, whether in respect of area, race, or geographical position, the differences between such countries are enormous.

But the important fact is that the leaders in world trade in proportion to population are those countries which we have already

[1] In the following tables I have taken total trade figures excluding re-imports; the percentages for export or import trades do not vary much.

seen have the lowest death-rate, the lowest infantile mortality rates, and the most efficient methods of climate control.

From the full table given in the Appendix it would appear that the countries with the greatest amount of world trade per ten million population are: [1]

New Zealand. 4·80	Denmark . 3·47	Norway . 2·65
Switzerland . 3·81	Australia . 3·06	Eire . . 2·53
Netherlands . 3·61	Canada. . 2·95	Sweden . 2·39
Belgium . 3·52	U.K. . . 2·94	

Is it merely a coincidence that these are countries where the mean temperature of the hottest month for the populated areas does not exceed 71° F. and the coldest month does not fall below 28° F. with the one exception of Canada, which, with the U.S.A., has probably the most efficient heating systems anywhere?

Is it still a coincidence that the death-rates and infantile mortality rates are exceptionally low for these countries, or that in each of them climate control is effectively practised in practically every household?

The second group consists of:

Argentine . 2·03	Finland . 1·54	Uruguay . 1·43
South Africa . 1·90	Austria. . 1·51	Germany . 1·37
France . . 1·59		

The position of the U.S.A., still lower, is in remarkable contrast to her position in the national income list. It is of course possible that a country with such striking natural resources and industrial ability as the U.S.A. may want little in the way of imports, but her manufacturers have always shown remarkable eagerness to sell abroad. Possibly, as has already been indicated, the tariff policy of the U.S.A. unduly restricts these figures.

The rest of the list follows with impressive agreement, and at the foot of the list we have countries where the death-rate and infantile mortality rates are abnormally high, and where climate control is non-existent.

Possibly the most curious coincidence of all is that New Zealand heads every list [2]—and is the outstanding example of a country with a climate very near to the ideal coupled with perfect climate control.

[1] Areas such as British Malaya, Cuba, and Algeria appear to rank unduly high. But in each of these areas, as in some others, industry and commerce are largely controlled by men from optimum climatic zones; where this does not happen so much, as in Siam, Ecuador, or Abyssinia, the relative standard is lower. Some caution must thus be exercised in interpreting trade figures for colonies, and I have excluded colonies from the final comparison.

[2] It heads the list for national income for the years 1936–37, but the Netherlands have better health statistics for those two years.

SUMMARY OF THE TESTS

If we take these four tests now, and consider the position of the various countries in them, we are at once struck by the fact that the following countries take a high place in each: New Zealand, Australia, the Netherlands, Switzerland, Canada, the United Kingdom, Denmark, Norway, the U.S.A., and Sweden, while the following regularly occur with a fairly high position: Eire, Belgium, the Argentine, Germany, Uruguay, and France. This list of leaders is in striking agreement with the list of countries given on page 88 as having an almost ideal summer and an easily controlled spring, autumn, and winter, and with the list given on page 91 of countries which have sufficient supplies of coal or electricity to make heating methods accessible to their inhabitants at reasonable prices.

Next in order on the combined lists are Finland, South Africa, Austria, Latvia, and Czechoslovakia, each of which has a climatic or fuel handicap of some kind compared with those countries listed above. Italy, Spain, and Japan are the largest countries in the next group. Finally, at the bottom of all lists are the tropical countries, or continental countries such as Siberia and China, where the extremes from winter to summer are most marked and fuel supplies scarce.

The comparison between meteorological conditions and these tests as far as Europe is concerned is brought out in the maps shown on pages 93, 98, and 104. I think these tests and this series of maps do tend to prove that civilization and energy depend to no little degree on climate and man's control of it.

X

ENERGY IN THE BRITISH ISLES

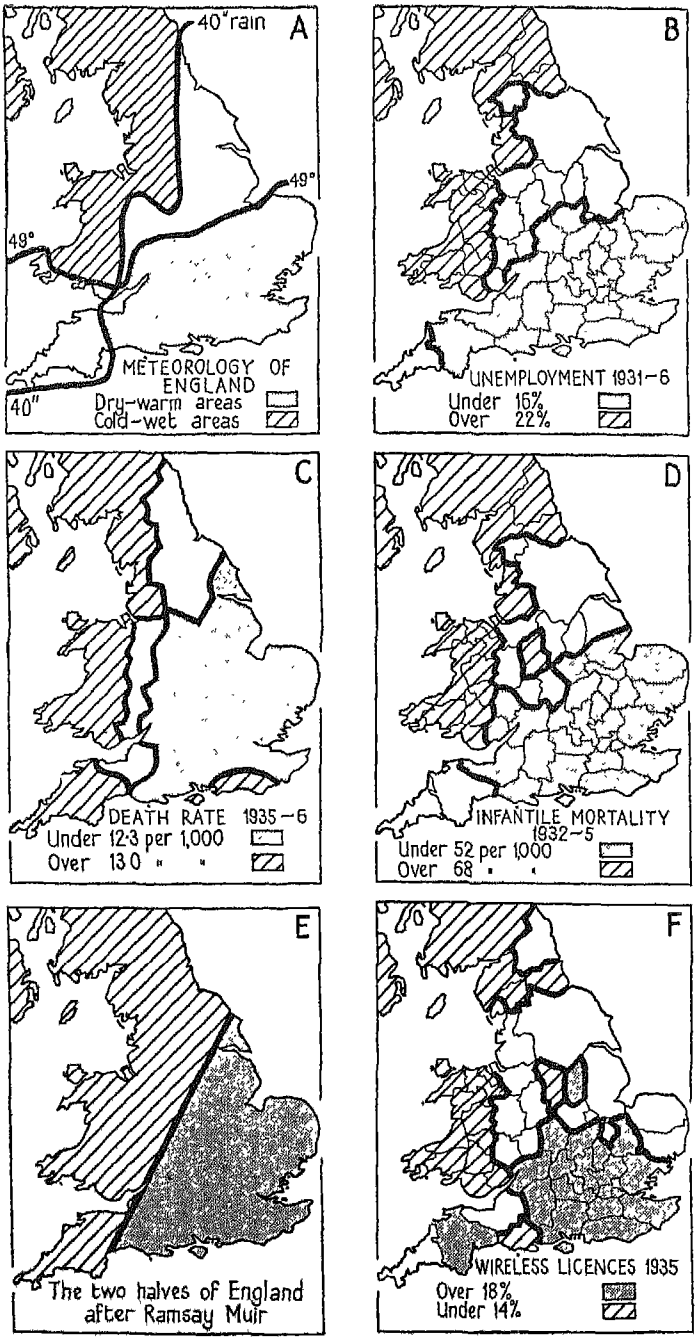
So far we have been using a large canvas and a bold design; it remains to be seen whether the principles already formulated can be applied to a smaller canvas with the same degree of scientific truth.

For this purpose it is obvious that we must have an area extremely well documented, whether from the point of view of meteorological information or any of the economic and cultural tests that might be applied. From any point of view, therefore, the British Isles is a good area to take for the purpose of such tests. For this small, comparatively compact area accurate meteorological statistics have been available for many years, and in other fields it might well be said that the available statistics are equal in accuracy and historical comparison to those compiled for or by any other country.

As we have before mentioned, the greatest handicaps that Britain suffers from climatically are cold and high humidity. It must, of course, be remembered that a high humidity carries with it great cloudiness and consequent lack of sunshine, but it does not necessarily mean heavy rain. According to a rainfall map, the area with the lightest rainfall in the country is Essex and the area surrounding the Wash, but a humidity map shows that the driest area is that extending roughly for 80 miles in every direction from Luton, but excluding the seaboard.

Obviously, if there is anything in the theory previously propounded, prosperity and culture should centre towards the south of this area, i.e. the dry-warm portion.

For the purpose of testing whether energy and health do tend to be better in the 'dry-warm' area I have taken two of the tests used in our national comparisons, namely the death-rate and infantile mortality, and in place of the income and trade tests, for which figures are not available by counties, I have chosen unemployment statistics. As a sort of cultural test, I give, also in map form, Ramsay Muir's divided map of England. It will be seen that his line cuts diagonally across England from Plymouth to Scarborough. From the south and east of this line, he says, in his *Historical Atlas* (p. 27), sprang nine-tenths of the men born before 1800 whose names find a place in the *Dictionary of National Biography*. I



CLIMATE AND ENERGY IN ENGLAND. (See pp. 115, 117)

have gone through the supplementary volumes of the *D.N.B.* and find that the south-east still leads, and this conclusion is strongly supported by Havelock Ellis's *Study of British Genius*. According to the latter, Norfolk, Herefordshire, Oxfordshire, Worcestershire, Hertfordshire, and Dorset have produced more great men per 100,000 of population than any other counties.

The first map (A) shows the average temperature and humidity in the British Isles. It will be seen that the driest region is the south and central part of England, and the most humid the Welsh, Scottish, and Irish coastal areas and Devon and Cornwall. Now if on this map we inscribe the 49° annual isotherm, it will be seen that the warmest-driest area of the British Isles is a group of counties running from Devon to the Wash and down to the south coast.

Comparable with these two maps are those (C) and (D) for infantile mortality and the death rates. These speak for themselves.

Above, at B, there is the map showing unemployment, 1931–36; this, too, requires no comment beyond the fact that at this period agricultural workers, domestic servants, and black-coated workers were not included in the insurance scheme, but nevertheless the figures give a fairly good indication of the prosperity or decline of a given area. The wireless map (F) is another indication of this kind.

Perhaps the first most striking agreement is that the counties with high unemployment are also the cold-wet areas, and that the counties with low unemployment are the warm-dry areas, and I suspect that if meteorology could be interpreted by counties, or unemployment by isotherms, there would be an even more impressive agreement.

There is one further series of facts that might be considered in this connection, and that is in the trend of industry.

If we survey the last two centuries of the history of England we notice that before the Industrial Revolution the main centres of population were in the South, and even in 1801 it could be said that those centres were south of the Bristol-Humber line. But with the coming of the Industrial Revolution, and the ever-growing demand for iron and coal, industry centred near the iron and coal fields, not because these were the best areas, by any means, from the point of view of climate, but because in those days transport was of such an elementary kind that unless a manufacturer sited his industry near to the coal and iron mines he was likely to suffer from failure of regular supplies and from high charges for their conveyance. If we add to this another factor, the development

of the textile industry, which demands a fairly humid atmosphere, we shall see that the trend of the population was necessarily towards south Lancashire and south Yorkshire, South Wales, and the Clyde.

But after the War of 1914–18 two factors of vast importance began to influence the siting of British industry. The first was the development of road transport, the second the transmission of electrical power. The motor-car and lorry and the development of electricity, with the establishment of a grid system throughout Britain, rendered it possible for the manufacturer to get his power as well as his supplies at any spot selected by him, and from 1922 onwards there began a great struggle between light or mobile industries established in the cold-wet areas and the same type of industries established in the dry-warm areas.

Industries are of two distinct kinds. The first may be termed geographical, and the second mobile. The geographical industries, such as mining or shipbuilding, must naturally be carried on where the mine or the sheltered waterway is. Neither quarry, nor mine, nor even breweries, can be displaced; but the manufacture of motor-cars, all forms indeed of engineering, of cloth-making, and a number of other industries or arts and crafts, can be easily moved about from place to place; these are the mobile industries.

The southerly trend of employment is strikingly illustrated in the annual reports of the Ministry of Labour.

The Report for 1938 states that during the period 1923–38 the number of insured persons in employment in Great Britain showed an average increase of 21 per cent., which was distributed as follows:

	Per cent.		*Per cent.*
London	+44	North-Western	+ 3
South-Eastern	+60	Northern	+ 1
South-Western	+40	Scotland	+11
Midlands	+28	Wales	− 9
North-Eastern	+12		

Thus, in Great Britain as a whole, both employment and the insured population substantially increased during the period, and the increase was predominantly in the south. In the northerly divisions, however, and markedly in Wales, employment failed to keep pace with the increase in the insured population.

This remarkable change is evidently to be attributed to the fact that the light industries are finding their way to the South. In this respect it is interesting to note in the 1931 Census of Production that the following light industries were already well

established in the South-East and London, and showed signs of developing with extreme rapidity:

PERCENTAGE OF TOTAL PRODUCTION OBTAINED IN THE SOUTH-EAST AND LONDON DIVISIONS, IN RESPECT OF THE FOLLOWING TRADES.

	Per cent.		*Per cent.*
Scientific Instruments	65	Paper	53
Radio	59	Animal Foods	48
Typewriters and Calculators.	58	Electrical Apparatus	46
		White Lead and Paints	46
Aircraft	57	Sugar and Sugar Confectionery.	43
Biscuits	55		

It is possible that in a few years' time, when this transitional period will have passed, we shall find the industrial centre of England coming ever nearer to the Luton-Salisbury area, and that in the block of counties surrounding this point unemployment will vary in ratio (as it now does) in terms of dry-warmth to cold-wet.

It may be noted in passing that even the smaller areas, such as London, show a direct relationship between these unemployment figures and relative humidity. The flat humid districts of the East End have long been noted for their poverty, and the higher and drier districts of the north-west for their prosperity. It might also be possible to draw up a mathematical equation to express the degree of prosperity a given group of people attain when placed in certain conditions of temperature and humidity.

I may say, furthermore, that such figures as are available for Germany, Denmark, and the Low Countries show an almost direct agreement with the relations indicated above.

As a note of caution it should be added that comparable charts for a few years may differ from those here given, but I would ask the reader to remember that natural forces can be confused temporarily by human action. From 1935 to 1938 the British Government was determined to modify the incidence of unemployment in the worst areas, and to this end offered great inducements to manufacturers to set up new industries in Cumberland, Durham, South Wales, and similar localities. The setting up of a single factory in a given area may have a great temporary influence on the unemployment figures; for example, the opening of the armament factory in the north-west helped to reduce the number of unemployed in that area by nearly 3000. Sooner or later the physical forces of nature will triumph and a wiser and better advised government would centre these new industries in areas where they have more

chance of competing successfully in world markets instead of in areas where they run greater risks of failure.

In short, it can be said that in an area so small as England there is very definite indication that mortality and unemployment are both low in the best climatic areas, and further, that industrial efficiency does seem to be affected by the outdoor climate as well as by man's control of it.

XI

THE JEWS AND THE 'POOR WHITES'

If the theory embodied in the previous chapters is sound, it must stand the test of antagonistic as well as of confirmatory factors. For example, if it is true that civilization advances with man's control over climatic conditions, is it also true that civilization deteriorates when man's control over his environment declines? We have already drawn instances of this kind from the history of Rome, but, as was then pointed out, data recorded 1500 years ago may not be considered essentially accurate.

The question therefore arises whether there is any people that has experienced every conceivable climate and adopted every method of climatic control during its history, and, if so, how was its civilization affected in the various phases of that history? There are two notable examples of such a people, the Semitic and the Nordic—that is to say, the Jews and some hundreds of thousands of the white races of north-west Europe. From the time of the fall of Jerusalem in A.D. 70 the Jews have spread over the face of the Old World; from the time of Columbus the white races have spread over the New World.

As regards the Jews, it will be remembered that their original home was directly along the 70° isotherm. From the time of Abraham onwards, throughout the imposing line of their prophets, kings, and judges, all their great leaders were born within a few miles of the 70° isotherm, which is shown on the map (p. 40). But in the course of the Dispersion, Jews in varying numbers went north, east, south, or west. Wherever they remained on or near the 70° isotherm they continued to flourish, but those that went south into Abyssinia, subsequently becoming Falashas, those that went so far afield as Cochin in India, and those who went to other tropical areas, all deteriorated, until to-day there is little left of those ancient colonies but a religious tradition and dwindling numbers. Their civilization gradually declined to lower levels, and their learning often became a meaningless rote.

Up to the fifteenth century every Jew of importance was born on, or near, the 70° isotherm, from Moses to Maimonides. But as the world centres of civilization moved north-west, so did the sequence of eminent Jews also come from the north-west. From 1500 to 1800 almost every Jew of importance was born in north-west

Europe, and since 1800 in North America or north-west Europe. Here is perhaps the most startling example of a homogeneous race subjected to varying conditions, and wherever those conditions differed greatly from the previous best, suffering a severe and almost tragic decline in civilization.

There are probably half a million Jews in Palestine and adjacent areas now, but the leadership of the movement comes, not from this ancient region, but from the new lands possessing climate control, and it is the Herschels, Rothschilds, and Weizmanns who now lead Jewry where formerly it was prophets, priests, and kings from the 70° isothermic area.

As the Jews in certain conditions have deteriorated, so also have the white races. However different the Provençal or the Italian is from the Scandinavian or Irishman, it is an astounding fact that during the last 400 years, whilst the white races have conquered the greater part of the earth, they have conquered tropical areas only at the expense of their own power, if by chance they have settled there. There are, of course, great areas, such as India, China, and the Dutch East Indies, where no permanent white settlement has taken place, but in comparable areas, such as portions of South Africa, the southern States of the U.S.A., and the West Indies, there has arisen the problem known to the world as that of the 'Poor White.'

In all 'Nordic' areas, unemployment, destitution, and lack of moral fibre are not unknown, but in the tropical and semi-tropical regions of the earth, wherever the white man has tried to settle, there has arisen an additional source of trouble which may be summarized as follows. When white men settle in warm climates the first generation appears to maintain its energy practically unimpaired, but those that follow show a gradual deterioration, a social and economic retrogression, until, as was illustrated in the play, *Tobacco Road*, the white man becomes, not only lazy, but also 'something considerably lower than a decent native.'

The problem presented by these degenerate white men has arisen in the southern States of the U.S.A., in South Africa, the British West Indies, various parts of South America, and other tropical or semi-tropical areas. It has not arisen to any extent in India, Burma, Malaya, or China, for here the European or American soldier, missionary, or trader has frequent periods of leave and returns home after his years of service. The extent of the problem may be gauged by the fact that in South Africa alone out of 2,000,000 whites no less than 300,000 are 'poor whites.' Here

is the opinion of the Hon. G. M. Huggins, Prime Minister of Southern Rhodesia, on the subject: [1]

Actually what is happening is this—and you can see it happening in the Union of South Africa. The less efficient class of white is pushed out of business by the native, and there are something like 300,000 poor whites in the Union of South Africa. I do not know how many of you have seen a 'poor white,' but he is something considerably lower than a decent native, although his skin is white. This is the result of the intimate contact of two civilizations, where there has been no attempt to direct and guide the energy and output of these various people. One of the things I have put up to the Colonial Office is that they should now, right away, make a survey of the whole of the British Empire Possessions, with the inclusion of the Union of South Africa, of course, and make up their minds which parts ought to be merely administered by white people, and in which parts white people are to be allowed to live, and propagate their species, and settle. Having done that, it will be perfectly easy then to allow the native to have an outlet for his greatest energies and his greatest ambitions and allow the white to survive.

Of course, it is an unpleasant fact—but you have to face facts in this matter—that in those areas where white settlement has been allowed, the indigenous native will not be allowed to have equality, either social or political. You have to face up to that and make it plain, and so make the position possible, and in that way help us to tackle this 'poor white' problem which is already commencing in Southern Rhodesia, and which has existed for some time in the Union.

Of the areas concerned, South Africa has been subjected to the most minute investigation. In 1928 the Carnegie Corporation of New York, backed by its almost limitless funds, originated a detailed inquiry into the 'poor white' problem in South Africa, employing for the purpose some of the finest brains in South Africa and America. The Commission was impartial and fearless, and its Report, *The Poor White Problem in South Africa* (5 volumes, 1932), covers the whole field from psychology to economics. I will not, however, interpret the Report: I will merely quote from their Joint Findings, and readers may draw their own conclusions.

According to the Report (I, vi–vii), the 'Poor Whites,' who number about 300,000, consist of:

(*a*) Persons of nomadic type;
(*b*) 'Bywoners,' farm labourers and shepherds, who often move about considerably;
(*c*) The 'Bushveld' type, living largely under pioneer conditions;
(*d*) The poor type of woodcutter;
(*e*) Small groups of indigent persons living along rivers or well-watered valleys;

[1] Speech in Westminster Hall, 18 July 1934.

(*f*) Former independent farmers. All these live under rural conditions;

(*g*) 'Poor Whites' who have moved to the small country towns and developed into 'Village Paupers';

(*h*) Those who have gone to bigger cities and earn a living as unskilled workers;

(*i*) Most of the people who try their luck on alluvial diggings;

(*j*) Persons for whom employment has been found on settlements and relief works or as manual labourers on railways.

For all these groups, except (*g*) and (*h*), the tent, wagon, or simple hut of reeds or rush mats was, and is, the usual dwelling place (I, 35–44), while the (*g*) and (*h*) groups become slum dwellers in the main (I, 220–222).

'About one-third of the dwellings inspected were unsuitable for civilized life. They were small, dirty, tumbledown, ill-furnished and unadorned. Another one-third were reasonably clean and orderly, but quite too small for family life. The rest consisted of simple, but respectable dwellings, meeting the requirements of civilized life. . . . With the few recent and praiseworthy exceptions, little is done in the cities to provide better housing; in rural areas practically nothing of this kind is done' (I, xviii). 'They occupy miserable untidy hovels' (V, 4).

Swellengrebel, 150 years ago, noted the primitive and degenerate conditions of pioneer farmers in the Karroo, 'living in primitively constructed mud or wattle and daub huts, without suitable windows, chimneys, or dividing walls.'

'The economic and social decline discussed is particularly noticeable among the white population of older settlement,' particularly Dutch farming stock, but 'we find the same typical forms of retrogression among some of the English-speaking community, who have been settled in South Africa for many years. . . . This [poor white] population had been severed from European progress and development for many generations, and lived chiefly under the simple conditions of a pioneer economy.' 'The manner of life of the rural population and their simple economic condition caused a type of mentality to develop . . . marked by narrowness of outlook, by lack of enterprise, and by a dread of the strange world outside the farm. . . . It must be admitted that a certain lack of industrious habits contributed to the process of impoverishment. . . . Great distances were (and often are to-day) an obstacle to market production, so that there was little incentive to increased exertion. In addition, they had gradually learned to reduce their wants' (I, vi–x). 'The patriarchal tradition, which was formerly very strong among

rural families, helped to keep the descendants in customary ways of farming. But it was also in many cases a cause of inexperience in business and of lack of initiative and self-reliance among the younger generation, as well as of over-populated farms' (I, xi).

'The data collected . . . shows a high mortality rate among children. Many of the dwellings are defective—often extremely so—in respect of construction, lighting, and ventilation. . . . This investigation seems to indicate that poverty and unsatisfactory diet generally had a more detrimental effect on their nutrition than malaria or other diseases. In principle, the results obtained from scholastic and intelligence tests support this conclusion, as "poor white" children suffering from malaria did not score less (or much less) in these tests than "poor white" children in most of the other areas. . . . Neither epidemic diseases, nor insufficient nor unsuitable diet, nor climate, play an important part among the great primary causes of impoverishment. But conditions of poverty and ignorance lead to lack of food and to wrong diet. This weakens the resistance to disease, reduces his working power, and so makes the problem more acute' (I, xiv). 'The great majority of poor whites are of normal intelligence' (I, xvii).

Such were the Joint Findings of the Commission. The supplementary individual reports strengthen these main conclusions of my own:

(1) The stock was originally the best in the world—since the parent nations of Holland, Germany, France, and Britain were, and are, among the world leaders of civilization.

(2) Only that portion of this stock which has been in the country for several generations shows signs of deterioration.

(3) Only that portion of the stock which has voluntarily relinquished climate control, or been compelled to relinquish it, has become 'poor white.'

(4) Of these 'poor whites,' those in areas where buildings are at their worst and climate control non-existent—as in the arid plateau to the North of the Union—are the most degenerate, while those who obtain urban employment, with its concomitant of greater climate control indoors, rehabilitate themselves.

The report does not say that absence of climate control is a cause of the mental and physical degeneration of 300,000 whites in South Africa (one in six of the whole white population)—in fact, it never mentions climate control—but it produces serried ranks of facts which show most clearly that the decline of the white is accompanied in *every instance* by a lack of heating arrangements,

lack of protection against the sun, and lack of cooling arrangements such as solid buildings.

I must devote one or two paragraphs to a detailed account of the South African climate. Mr. W. A. Murray, who reports on 'Health Factors' in the publication we have mentioned, records that, 'The natural environment of the farmer and his family was on the whole healthy and favourable. . . . The climate was more favourable, with no very great extremes of heat or cold' (IV, 6). The mean monthly temperatures for the warmer and colder months of the Capetown–Durban area are 58° F. and 71° F., and of the Johannesburg–Pretoria area 50° F. and 67° F.—*almost* an ideal climate—so near the ideal that people forget to take precautions in the hot or in the cold weather. But in the areas outside those mentioned, the range extends from 40° F. to 72° F. at Moyeni and from 51° F. to 77° F. at Kenhardt. It is in these areas, outside the great cities, that the poor white problem originated, and continues acutely. At Frazerburg, Brakfontein, Hanover, Lindley, and many other places, the average night minimum temperature of the coldest month is below 30° F., and over the Union as a whole mostly below 40° F. By contrast, the average day maximum temperature rises to 92·5° F. in the warmest month at Umsinga and over 80° F. at most places in the Union. As we have seen earlier, 80° F. in the shade is often 120° F. or more in the sun, and almost without exception these 'poor whites' are much exposed to external conditions, having neither cool rooms, fire-places, chimneys, nor electric appliances. The cooking is usually done out of doors, but fuel is scarce.

In the first chapter of this book we have seen that industrially the energy of the white worker diminishes when temperatures pass the ideal range; in the 'poor white' problem we have this unpalatable truth emphasized when unfavourable climatic conditions persist over many years.

Many have ascribed this deterioration of the whites to 'the intimate contact of two civilizations,' the lower pulling down the higher, but this has not happened in Canada, in New Zealand, or in the northern portion of the United States, for in these areas the Redskin and the Maori appear to be working up to white level, the pace apparently depending on the extent to which the 'natives' adopt the white methods of climate control. Huntington, too, has pointed out that in the U.S.A. the northern negro farmer is more efficient than the southern white farmer.

Thus, whereas the original 'poor white' came from an area

where indoor temperatures could easily be controlled all the year round—and *were* controlled, he emigrated to an area where temperature could not be controlled during the two or three hot months of the year, and were not controlled during the one or two cold months of the year. He perspired at rest in the summer; he shivered at rest in the winter.

I cannot resist quoting one recommendation from the Report that seems to summarize the cause and the cure at once—'It should be the aim of education to help people to control their immediate environment.' This is precisely my view.

XII

WHAT OF THE FUTURE?

THIS book was written and almost ready for the press on the eve of the present war, and it will readily be understood that there have been few opportunities in the interval to improve it. But it may be desirable to add a few words on the relative strengths of combatants, the probable result of the war, and its aftermath, if the problem is viewed solely in the light of climatic conditions.

When war broke out in 1939 Germany and Austria (plus the industry of Czechoslovakia) were matched against Poland, France, and Britain. Germany's strength was magnificently organized and secured startling and historic advantages both over Poland and subsequently over Denmark, Norway, Holland, Belgium, and France. From June 1940 to June 1941, therefore, practically all western Europe and Italy were lined up against the British Empire, and in the Battle of Britain we could observe (as well as take part in) a struggle which, on the analysis given in this book, could not have been won either by Germany (plus Austria and Italy) nor by the British Empire without outside aid. 'Lease-lend' would undoubtedly have helped considerably, but the matching of powers was roughly 70,000,000 British from optimum climatic zones, with assistance from India and the Colonies, against nearly 100,000,000 Central Europeans, assisted by southern Italians not included in the above figures and certain Balkan units.

But in June 1941 Hitler invaded Russia. From the foregoing chapters it is obvious that Russia, although low in the scale of civilization in the early part of this century, has, like Japan, been acquiring climatic controls, and her position in mid-1940 was vastly stronger in every way than in 1931, which is the central statistical date for this book. History has shown that 180,000,000 Russians, plus 'Lease-lend,' could contain, not the full strength of Germany, but that part available after the policing of Europe, the Libyan campaigns, and the air and sea war against Britain had been met. Russia alone against Germany, Austria, Hungary, Finland, Roumania, and Italy would have been no match.

In December 1941 the war increased by the accession of Japan to the Axis, and of the United States and certain other American states to the Allies. At once the whole balance shifted, and whilst Japan might initially win battles against American, British, or

other Allied forces, the whole weight of the war was now against the Axis. The potential punching power of the Allies became approximately 200,000,000 men from optimum climatic zones compared with 110,000,000 on the Axis side. But the Allied countries had further the support of 180,000,000 from secondary zones and 500,000,000 in the tropics, whereas Germany, Finland, Austria, Hungary, Italy, and Japan have but the Bulgarians and Roumanians to assist them. The organizing of so much power on the Allied side will take time; but however long it takes, the result is inevitable.

Peace will not restore the world of 1939. The U.S.A. will be greater than ever in power and influence. Germany, subdued, will be unsubduable. Twice has she fought for supremacy in Europe and twice will be defeated—but Germany will survive. That great space between France and Poland will continue to produce a race high in optimum values, and if she can achieve post-war alliance with her neighbours (which may indeed be Europe's reply to Anglo-Saxon supremacy) Germany may yet achieve her place in the European sun. If her diplomacy had been as good as her will to war, Germany could by now have dominated Europe.

A glance at the climate map on p. 84 shows that the area from the Bay of Biscay to the Baltic is the largest single area in the world with good climatic conditions, and it is moreover the most densely populated. If this area ever comes under a single direction, whether by conquest, federation, or alliance, and has an inner unity, it will become the dominating aggregation in the world.

But factors other than conquests, alliances, or federations help to shape world history, as we have seen in Chapters V and VI, and not least of these are man's migratory habits and his growing control of his indoor environment. Man is a restless animal and ever on the move, and in late years we have seen how Russia has, as a matter of national policy, sited certain industries (and consequently many tens of thousands of families) in areas less climatically favourable than her western margin. Unless there are outstanding developments in indoor heating, etc., the next generation of Russians may therefore have greater climatic extremes to endure than the pre-war generation.

Similarly in South Africa, Canada, and Australia there appear to be movements inland, and even as the Karroo is already taking its toll of South African efficiency, so may the Prairie Provinces and Queensland take their toll of Canadian and Australian efficiency. Winnipeg, for example, has one of the hardest climates in the world, surpassed in inclemency only by Siberia and the interior of Green-

and; in 1871 its population was 241; to-day it is 220,000. Calgary, :oo, with an equally hard climate, was non-existent in 1881; to-day .ts population is 84,000. Fifty years ago the total population of the Prairie Provinces was about 100,000; to-day it is over 2,530,000. Winters all over this area are twenty to thirty degrees colder than winters in Toronto.

Similarly, in Australia, the population of Queensland has increased from about 200,000 in 1881 to over 1,000,000 to-day, and at Brisbane the mean temperature of the coolest month is 58·5° F. and of January is 77° F., accompanied by high relative humidity.

In each of these areas the emigrants that have built them up came from more favoured lands; they brought their energy with them, and for a time these areas are bound to reflect that energy. But sooner or later climate will tell. We have seen in South Africa that the 'poor white' problem has developed relentlessly over two centuries, but Queensland and the Prairie Provinces of Canada have not yet been settled extensively for two generations.

Sir R. Cilento and others have urged that Queensland is as good as any other area provided adequate attention is given to housing and sanitation. I would modify this slightly by saying that if Queensland can acquire climate controls against heat and humidity it will progress as fast as any area in the world.

The U.S.A. is also faced with similar developments. All the area from the Rockies to the Appalachians has a less favourable climate than the New England States; but California, Oregon, and Washington have a climate even better than the latter. If the trend of population is to the Pacific States (as I think it is), the U.S.A. will add to its energy, but if it is to the central States, or to the warm moist areas, we may expect a decline.

But the U.S.A. is solving its problem in another way, for whilst 4000 deaths from heat were reported in August 1936 from the central States, with temperatures of 104° F. being registered in Oklahoma and Kansas, the same newspapers referred to the fact that the number of air-conditioned factories, cinemas, shops, and apartment houses was increasing daily. Far down in the basement of these buildings, great machines draw in the sticky vitiated atmosphere, filter it through oil-saturated blankets of spun glass or steel wool, wash it, cool it, dry it, and send it up again fresh and brisk. Railways, too, have their air-conditioning plants; over 10,000 railway coaches have been fitted with the new device which provides clean air without draughts.

One company in New York found that air-conditioning improved efficiency and freedom from illness by one-third, and in the offices in Rockefeller Centre, the Empire State, and Chrysler Buildings, both colds and traffic noises are excluded. In the immediate pre-war years air-conditioning was spreading to private houses. For as little as £100 an air-conditioning plant could be installed, with running costs about the same as those of domestic refrigerators.

At the risk of descending to the slightly absurd, I must quote an advertisement from *The Saturday Evening Post*, advertising, in mid 1939, a chain of hotels:

> You won't see (or need) a fan in our hotels, even on the hottest days. For we've taken the swelter out of summer. Restaurants, public rooms and convention hall, even a number of guest rooms, at slightly extra cost, are comfortably 'air-cooled.'
>
> Air-cooled, but not too cool. You won't need a fur coat either, or a bottle of cough syrup. Our weather-makers have temperate ideas. And cool you off by degrees . . . 15° or so, just the right number. So you'll find you have more pep and go than you'd have believed possible in summer. You'll be eating from top to bottom of the menu. Dancing till closing time. Sleeping like Rip Van Winkle. And keeping clear-headed and comfortable, even if the Mercury itself gets dizzy with the heat outside.
>
> This summer, whether you're travelling on business or pleasure, better make a point of stopping at one of our air-conditioned oases. You'll find the welcome as warm as the hotels are cool. . . .

Allowing a little for the exuberance of the advertisement, the facts are obvious—mankind is on the verge of a development which may alter the whole focus of civilization. Already Canada is experimenting in the 'insulation' of houses for use in conjunction with air-conditioning, and the National Research Council is busy recommending new systems of central heating for Canadian homes that will make houses fit to live in when the thermometer goes 20° or 30° below zero, without half the householder's income being spent on fuel. But whilst all this may add to North American efficiency, we must not forget that climate control ceases on the doorstep, and that the natural climate plays its part in affecting human energy the moment we leave the house, railway coach, or motor-car. Thus, the new centres of civilization will not be in the heart of continents, but will remain near the sea. The northern Mediterranean, California, New Zealand, and Japan seem to be the obvious areas if air-conditioning develops.

On the other hand there have been considerable recent improvements in the control of cold and damp. As has been pointed out on p. 75, whilst coal fires or stoves were in use all over north-west

Europe several centuries ago, it was not until quite recently that electricity, gas heating (as apart from gas lighting), and oil heating began generally to add to our environmental control, and it is only since 1919 that the average Englishman has taken to the electric fire as a means of warming his bedroom, where a not unimportant part of one's day is spent.

In my own lifetime I have seen the average English family pass from a single fire—the kitchen grate or range, with perhaps a fire in the parlour on Sundays—to a state of things where almost any room, from the bedrooms to the bathroom, can be warmed speedily by one or other of modern appliances. And the generation now in its twenties or younger is the first generation in English history to enjoy these amenities. But there are still many English villages where there is neither gas nor electricity, and the proportion rises rapidly in Scotland, Ireland, and Wales.

Therefore, as heating systems develop further I expect north-west Europe and similar climatic areas to show still better vital statistics, and indeed to continue to lead the world for a generation or so, but I do not expect their percentage of world trade to increase —for here, I think, Russia, Japan, Poland, and other nations late in developing will proceed to take an ever-growing share.

But in comparative progress I think the Argentine will take first place. Few realize the great strides this country had made prior to 1940, and this part of the world is the only part enjoying an optimum climate which is untouched by war. Whilst civilization in Europe has had a check of infinite severity, and in North America, Australia, and Japan a relative check, in the Argentine and Uruguay it has been forging ahead. Moreover, the Argentine is rapidly acquiring climatic controls and a sufficient population.

Pending the arrival of air-conditioning at economic rates, the areas of this world most worth living in from the point of view of energy, health, and efficiency—the desirable realms of the next decade or so—are New Zealand, the Pacific States, South-east Australia, the Netherlands, Switzerland, South-eastern England, and similar climatic areas. When air-conditioning arrives, the desirable realms will be slightly farther south (or north in the southern hemisphere), possibly along the 60° annual isotherm.

We have seen how civilization follows man's control of his own environment. For man is the product of his environment; his energy, his health, his progress depend upon it. In human history, clothing, tools, and the control of cold, heat, and damp replace natural selection. I believe we are on the eve of developments greater

than those of the past, for air-conditioning, and electrical developments in many forms, will give man not only still greater control of damp and cold, but of heat and dryness, and whilst the desert may not yet blossom as the rose, it may blossom once again with keen alert minds. The negro may yet be saved from mental darkness and reach heights of intellectual attainment undreamt of by Booker T. Washington; the Semite and the Chinese, the Indian, the Latin, and the Greek may, by climate control, leap forward again into the van of scientific progress. Possibly, however, new energy may only produce greater antagonisms, for history teaches us that civilization brings new terrors to war, new fevers for riches, new modes of human exploitation.

Is it too much to hope that, when all men can enjoy the serenity of ideal indoor conditions, the thirst for mortal power will give place to the thirst for mental poise, and to the lust for light?

In the past mankind has blundered into civilization. With the knowledge before us we know that the populous nation which can keep its citizens, all its citizens, in ideal climatic conditions, whether *indoor or outdoor*, will have a great opportunity to lead the world in health, energy, trade, and culture.

APPENDIX I

Climatic Conditions of Various Countries

Country	Population 1931	Mean Annual Temp. °F.	Coldest Month Temp. °F.	Coldest Month Relative Humidity per cent.	Warmest Month Temp. °F.	Warmest Month Relative Humidity per cent.	Range °F.
Russia in Asia	40,000,000	34·0	−1	..	67·0	..	68
Russia in Europe	124,000,000	40·0	16·0	76	65·0	71	49
Finland	3,486,000	40·4	20·0	88	63·0	73	43
Esthonia	1,122,000	40·6	21·0	88	63·0	73	42
Latvia	1,900,000	42·8	23·0	87	64·0	72	41
Norway	2,829,000	43·0	27·0	84	62·0	70	35
Sweden	6,142,000	43·0	28·0	86	62·0	68	34
Lithuania	2,350,000	43·2	26·0	89	66·0	76	40
Canada	10,377,000	44·0	18·0	82	68·0	72	50
Poland	32,133,000	46·0	26·0	87	66·0	72	40
Denmark	3,574,000	46·0	31·5	88	62·0	75	31
Germany	64,900,000	48·0	32·0	85	65·0	71	33
Czecho-slovakia	14,935,000	48·0	29 0	85	66·0	70	37
Switzerland	4,097,000	48·5	32·0	85	65·7	72	33
Belgium	8,122,500	48·5	35·0	86	63·0	76	28
Austria	6,720,000	49·0	30·0	83	67·5	67	37
United Kingdom	46,037,000	49·0	40·0	86	61·0	74	21
Irish Free State	2,969,000	50·0	43·0	86	60·0	81	17
Hungary	8,750,000	50·0	28·3	86	71·3	62	43
Netherlands	8,036,000	50·0	37·0	89	64·0	76	27
Roumania	18,250,000	51·0	26·0	84	73·0	60	47
Bulgaria	5,900,000	52·0	30·0	82	71·0	65	41
U.S.A.	124,000,000	52·0	31·0	77	73·0	69	42
California	6,000,000	58·0	51·5	71	64·5	75	13
North-east*	60,000,000	51·4	29·0	73	77·0	68	48
South-east†	12,000,000	64·0	48·0	79	78·0	77	30
Yugoslavia	13,934,000	53·0	32·0	80	72·0	62	40
France	41,835,000	53·0	39·0	85	68·0	69	29
New Zealand	1,519,000	55·5	48·0	81	63·0	74	15
Chile	4,300,000	56·5	48·0	82	66·0	61	18
Japan	65,312,000	57·8	38·0	69	79·0	79	41
Italy	41,177,000	59·0	42·0	75	76·0	59	34
Spain	23,800,000	59·3	45·4	77	76·4	60	31

* Area north and east of Washington, St Louis, and St Paul.
† Area south and east of Memphis.

Country	Population 1931	Mean Annual Temp. °F.	Coldest Month		Warmest Month	
			Temp. °F.	Relative Humidity per cent.	Temp. °F.	Relative Humidity per cent.
Persia .	9,000,000	59·0	30·0	80	82·0	48
Turkey .	14,700,000	59·6	42·0	74	76·0	54
Portugal .	6,450,000	60·0	50·0	81	71·0	63
Mexico * .	16,850,000	61·0	55·0	58	66·0	70
Argentine .	11,672,000	61·0	48·0	84	74·0	72
Uruguay .	1,955,000	62·0	50·0	77	73·0	66
Australia .	6,545,000	61·8	52·0	78	71·0	62
China .	360,000,000	62·0	40·0	72	82·0	81
North of 30°		58·0	34·0	73	81·0	81
South of 30°		66·0	47·0	72	83·0	82
Syria . .	2,900,000	62·0	48·0	80	76·0	66
S. Africa .	8,281,000	62·5	54·0	66	70·0	68
South † .		65·0	58·0	85	71·0	72
North-east ‡		61·0	50·0	52	67·0	71
Greece .	6,470,000	63·0	46·0	74	81·0	52
Palestine .	1,035,000	64·0	48·0	76	77·0	66
Peru * .	6,500,000	65·0	60·0	79	72·0	86
Morocco (Fr.)	5,405,000	65·0	53·0	78	79·0	66
S. Rhodesia *	1,109,000	66·0	56·6	60	72·0	70
Ecuador * .	1,950,000	67·0	66·0	75	68·0	79
Egypt . .	14,804,000	70·0	55·0	65	82·0	57
Iraq . .	3,000,000	71·0	48·0	80	85·0	43
Kenya * .	3,025,000	71·0	67·0	81	74·0	75
Venezuela *	3,150,000	71·0	69·0	80	74·0	81 (July)
Brazil * .	42,000,000	72·0	67·0	81	77·0	81
Salvador * .	1,475,000	73·6	71·4	84	76·3	72
British W. Indies *	1,640,000	76·0	74·5	79	78·5	74
Cuba * .	3,962,000	77·0	72·0	76	82·0	74
Belgian Congo *	9,500,000	78·0	72·0	69 (Aug.)	81·0	82
Liberia * .	2,000,000	78·0	74·0	90	83·0	82
India * .	352,786,000	79·0	69·0	75	88·0	72
Haiti * .	2,300,000	79·0	76·0	65	82·0	70
French Indo-China *	21,452,000	79·0	72·0	79	85·0	82
Nigeria * .	19,000,000	80·0	76·0	75	82·0	80
Ceylon * .	5,313,000	80·0	78·0	74	83·0	78
British Malaya *	4,350,000	80·0	79·0	82	82·0	76
Burma * .	14,665,000	81·5	76·0	82	87·0	86
Siam * .	12,050,000	82·0	77·0	79	85·0	75
Sudan * .	5,508,000	84·0	73·0	32	93·0	22

* Tropics. † Cape Town and Durban area.

APPENDIX II

Percentage of World Trade per Country and per Ten Millions Population

Country	*Population* 1931	*Percentage per Country* 1926–1935	*Proportion per* 10,000,000 *Population*
United Kingdom	46,037,000	13·48	2·94
U.S.A.	124,000,000	12·17	0·99
Germany	64,900,000	8·86	1·37
France	41,835,000	6·63	1·59
Canada	10,377,000	3·08	2·95
Japan	65,312,000	3·06	0·47
India	352,786,000	2·91	0·08
Netherlands	8,036,340	2·9	3·61
Belgium	8,122,500	2·85	3·52
Italy	41,177,000	2·77	0·67
Argentine	11,672,000	2·37	2·03
China	360,000,000	2·18	0·06
Australia	6,545,000	2·01	3·10
Czechoslovakia	14,935,000	1·60	1·08
S. Africa	8,281,000	1·57	1·90
Switzerland	4,097,000	1·56	3·81
British Malaya	4,350,000	1·48	3·40
Sweden	6,142,000	1·47	2·39
Dutch East Indies	60,900,000	1·45	0·24
Russia (U.S.S.R.)	164,500,000	1·45	0·08
Denmark	3,574,000	1·34	3·47
Brazil	42,000,000	1·30	0·31
Spain	23,800,000	1·28	0·54
Austria	6,720,000	1·02	1·51
Poland	32,133,000	0·88	0·27
Algeria	6,554,000	0·82	1·25
Egypt	14,804,000	0·77	0·52
Norway	2,829,000	0·76	2·65
Irish Free State	2,969,000	0·75	2·53
New Zealand	1,519,000	0·73	4·80
Mexico	16,850,000	0·68	0·40
Cuba	3,962,000	0·63	1·59
Korea	21,365,000	0·61	0·29
Roumania	18,250,000	0·59	0·32
Finland	3,486,000	0·54	1·54
Hungary	8,750,000	0·54	0·62
Philippines	12,450,000	0·49	0·39
Chile	4,360,000	0·49	1·14
Ceylon	5,313,000	0·43	0·81
Yugoslavia	13,934,000	0·40	0·29

Country	*Population* 1931	*Percentage per Country* 1926–1935	*Proportion per* 10,000,000 *Population*
Venezuela	3,150,000	0·38	1·21
Greece	6,470,000	0·36	0·56
Formosa	4,708,000	0·35	0·74
French Indo-China	21,452,000	0·34	0·16
Turkey	14,700,000	0·32	0·22
Portugal	6,450,000	0·30	0·46
Persia	8,950,000	0·30	0·33
Siam	12,050,000	0·29	0·24
Uruguay	1,955,000	0·28	1·43
Tunis	2,411,000	0·26	1·08
Peru	6,450,000	0·26	0·40
Morocco (Fr.)	5,405,000	0·25	0·46
Nigeria	19,158,000	0·22	0·11
Latvia	1,900,000	0·15	0·80
Bulgaria	5,900,000	0·14	0·27
Esthonia	1,120,000	0·09	0·80
Bolivia	3,000,000	0·11	0·36
Guatemala	2,200,000	0·10	0·48
Sudan	5,530,000	0·09	0·17
Iraq	3,300,000	0·08	0·24
Lithuania	2,320,000	0·08	0·35
Palestine	1,035,000	0·06	0·56
Salvador	1,475,000	0·05	0·33
Haiti	2,600,000	0·06	0·23
Ecuador	2,000,000	0·04	0·20
Paraguay	890,000	0·04	0·45
Nicaragua	800,000	0·03	0·36
Panama	475,000	0·02	0·42

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